Geodætes Practicus Redivivus.

THE ART OF SURVEYING:

Formerly Publish'd by *Vincent Wing*, Math.

NOW

Much Augmented and Improv'd; with an APPENDIX thereunto subjoin'd, shewing the whole ART of SURVEYING by a New Instrument,

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The EMPERIAL TABLE;

Performing exactly in all respects, and in all Cases that can possibly happen in the Practical Part of SURVEYING, the Work of the *Theodolite*, *Circumferentor*, *Semi-Circle*, *Chard* and *Needle*.

WITH THE

DESCRIPTION and USE

OF A

NEW QUADRANT.

To which is Added by way of Supplement,

SCIENTIA STELLARUM:

Containing New and Accurate Tables of the Planetary Motions, whereby the Planets Places both in Longitude and Latitude, The Places of the Fixed Stars, with the Eclipses of the Luminaries, are more easily attain'd, than by any yet Extant.

By JOHN WING, *Math.*

LONDON,

Printed by *J. Matthews*, for *Awnsham* and *John Churchill*, at the *Black Swan* in *Pater-Noster-Row*, MDCC.

TO THE

HONOURABLE

JOHN NOEL Esq;

Son to the Right Honourable the *LORD CAMPDEN*, and Brother to the late Earl of *GAINSBOROUGH*.

Right Honourable,

THE *Arts and Sciences Mathematical have in former Ages not only Received the Applause and Approbation of the Learned, but the Professors thereof have been also more favourably and gratefully admitted into the Society of the Noblest Persons, and it would be Weakness in me to tell your Honour of the Worth and Excellency of that, which all Great Men do approve and admire. That worthy* Syracusean ARCHIMEDES, *has left us such Excellent Helps and Devices* Mathematical, *that all the World since hath been beholden to his Pains and Industry; and should I enumerate the continual advantages and benefits we daily receive from the* Mathematical Sciences (*especially to your Honour*) *it would be like reading a Military Lecture before the Illustrious* Hanibal; *who in his Time, was the greatest Master of the Art of War: I must therefore only beg your Honour's favourable Acceptance of this my Performance. And*

as

as the Grand Cyrus *graciously accepted a Cup of Water from poor* Sineætes, *so let me be allowed Your Honour's kind Reception; And I hope it will not detract from Your Honour to Patronize my Slender Labours; which will not only encourage me to make a further Progress in this Sublime Study, but confirm me in what I have already done, and oblige me to a Dependence upon the Rays of Your known Humanity, by encouraging me to Study what may be further serviceable to the Publick: In the interim, committing YOU, Right Honourable, and Your Noble Family, to the great Architect of Heaven and Earth, I cease to trouble Your Honour further at this time, ever remaining,*

A Real Honourer of YOU
and
Your Noble Family,

JOHN WING.

THE

TO THE
READER.

Courteous Reader,

AS I have been this Twenty Six Years last past, imploy'd in matters of great concernment, in the Practice of Surveying: I may (I hope) contend for some Experience, (if not Judgment) in this Noble Science, and my frequent experience discovered to me, the great want of such an Instrument, as might be truly subservient in all Cases that may happen in this excellent Art of Surveying: Upon which, I betook my self to the contriving and perfecting such an Instrument as is Describ'd, Illustrated, and Exemplified in the *Appendix* to the Fourth Book; truly and exactly performing, (and that most Naturally) all the Cases that can possibly happen in the Practical part of Surveying; and having communicated my Conceptions upon this Subject to several Ingenious Artists, who not only approving the matter, but earnestly importun'd me to publish it: Accordingly, I did then design to make a Compleat body of this most Useful Art in *Folio* by it self; but others at the same time desiring me to Revive my Deceased Uncle, Mr. *Vincent Wing*'s Book of Surveying, which was almost lost to the World, as being out of Print: I did then in Compliance to all, Revive this Deceased Author's Book, *viz.* the Essential part thereof, that of little Use being left out, and having made such large Additions, and and that wholy New, as are not only Useful but truly Serviceable to a Work of this Nature, and tho' several able Artists have already handled this Subject with good Success, that may give some occasion to Object that my undertaking is Superfluous, I therefore think my self obliged to inform my Reader

that here are ſeveral advances made in this Tract towards the bringing this Noble Science to greater perfection, and may lead the Young Reader through the Study and Practice thereof with more eaſe, Expedition, and Satisfaction, than any that has hitherto appeared in our Language, as may in ſome meaſure appear from this ſhort Specimen of the whole Work, which is divided into Seven Books; as follows,

I. The firſt Book contains *Arithmetic* in whole Numbers, Vulgar Fractions, and Decimals, after a Plain and Practicable manner.

II. The Second Book conſiſts of *Geometry*, being divided into four Parts. The firſt part treats of the Deſcription and Inſcription of all Geometrical Figures. The ſecond part contains the Menſuration of all Superficial Figures, demonſtrated in Problems, Theorems, Definitions; and *Arithmetically Solv'd*. The third part directs the parting or cutting any Geometrical Figure into equal or unequal parts, as the matter is required. The fourth part teacheth how to Reduce one Figure into another, ſtill keeping the ſame proportion.

III. The third Book conſiſts of *Plain Trigonometry* or the *Solution* of all Plain-Triangles, both Right and Oblique, with a Canon of Sines and Tangents to every 10 Minutes, with a Table of Logarithms to 1000.

IV. The fourth Book ſhews by the *Plain-Table* how to take the Plot of all manner of Grounds ſeveral ways, and how to caſt up the juſt quantity thereof in Acres, Roods, and Perches, and alſo how to incloſe a Lord-ſhip that Lieth in common, or open Fields, and to draw a perfect Mapp thereof. To which Book is Subjoyn'd an *APPENDIX*, wherein is the Deſcription and Uſe of a New Inſtrument call'd *EMPERIAL TABLE*, with a New Scale and Chain fitted thereto, performing exactly and in all Reſpects the work of the *Plain-Table*, *Circumferenter*, *Semicircle*, *Peractor*, *Chard* and *Needle*, all fully compleated

compleated thereon, without the least confusion of Lines or Parts; and from this Instrument by each several way, both Separately and Conjunctively, is demonstrated all Practicable Cases that may possibly happen in the Art of Surveying, either in Kingdoms, Provinces, or private Estates.

V. The Fifth Book shews *Arithmetically* how to measure all manner of Work and Materials belonging to *Buildings*, to which is added, the Rates, and Prices both of Work and Materials; by which any Gentleman may know, what his Building shall cost him before he begins the Work.

VI. The Sixth Book contains the Description and Use of a *New Quadrant*, plainly resolving the *Hour* and *Azimuth*, the *Right Ascension*, *Declination*, *Oblique Ascension* and *Decension* in time, of all points of the Ecliptic with Latitude, and thereby the Rising, Southing, and setting of the Planets and Fixed Stars; also the Sun's Rising and Setting, with the Increase and Decrease of the Days to a Minute; and on the back-side of the Quadrant, are Lines inserted for the erecting a Scheme of the Heavens, for any time, and also Lines shewing the Diameter, Circumference, Area, and Square equal of a Circle; with an Useful Almanack, and other Quadrantal performances.

VII. The Seventh Book consists of several Problems in Geography, and Spherical Trigonometry, whereby the Reader may be inform'd how to find the Scituation of any place upon the Terrestrial Globe; and thence transferr it into a Map. To which end are annexed the most necessary Problems in Astronomy, and a Practical Tract of the Art of Dialling, with which all Surveyors ought to be acquainted; that they may give directions for Ornamental ones, upon such Mansion-Houses as belong to the Mannor or Land which they Survey.

To these is added *SCIENTIA STELLARUM*, consisting of New Astronomical Tables Exposed, with their Uses in the Calculation of the Planets

nets Places, both in Longitude and Latitude, as also the Doctrine of the Eclipses, with the places of the Fixed Stars, *&c.*

Now the Utility of the Mathematick Sciences, being so well known, that for me to commend them, would be like speaking before *Apollo*, and therefore needless: But as to what oversights and omissions have escaped, I submit to the Censure of all Impartial Artists, knowing tis an easy matter (where Prejudice doth not stop the way) for the Reader to distinguish between the Author's, and Printer's faults, but having the Advantage of a *Good Printer*, and a *Careful* and *Ingenious Corrector*, who have so excellently behaved themselves herein, that very little of an *Errata* appears, to what I have seen in most works of this Nature. Thus wishing all Ingenious, Impartial, and Unprejudiced Artists a happy Progress in all their Just endeavours, I remain

From my House at *Pickworth* in the County of *Rutland*, *November 27th*, 1699.

Your Mathematical Friend,

JOHN WING.

THE ART OF SURVEYING.

Common Arithmetick.

BOOK I.

CHAP. I.

Of Notation, or Numeration.

I. ARITHMETICK is the Art of Numbering, or Accompting by Numbers.

II. *Arithmetick* is either Single, or Compound.

III. Single, is that which is performed by single Numbers alone, and consists of two Parts, *viz.* Notation, and Numeration.

IV. Notation is only the Noting, or Writing down any Summ, or Number that is to be pronounced, or its Value expressed or determined.

V. Numeration is the Reading, or Expressing any Number given, or propounded; or the exact pronouncing its true Value, according to the Number of Figures proposed, or noted down.

VI. The Notes, or Characters, are Nine, and a Cypher (0), by which Numbers are usually expressed, and are as followeth; 1, one; 2, two; 3, three; 4, four; 5, five; 6, six; 7, seven; 8, eight; 9, nine; 0, Cypher.

VII. Tho' the Cypher signifie nothing of it self, yet it being post-poned, or placed behind any of the rest, it doth increase the Value of the Number, as hereafter will appear.

VIII. The Figures are to be numbred, and the Order of Places to be obſerved from the Right-hand to the Left.

IX. The firſt Figure of any given Number to be read, or pronounced, toward the Right-hand, is ſaid to ſtand in the Firſt place, or place of Units; the Figure ſtanding in the Second place, is called the place of Tens; the Third, the place of Hundreds; the Fourth, the place of Thouſands; the Fifth, the place of Tens of Thouſands; the Sixth, the place of Hundreds of Thouſands; the Seventh, the place of Millions; the Eighth, the place of Tens of Millions; the Ninth, the place of Hundreds of Millions; and the reſt as the Table of Numeration here expreſſes.

X. The firſt three Figures towards the Right-hand, poſſeſs the place of Hundreds, the three next on the Left-hand them, ſtand in the place of Thouſands, the three next in the place of Millions; and ſo on, as the following Table of Numeration directs.

XI. The aforeſaid, or foregoing Rules being underſtood, 'tis eaſie to expreſs, or read, the Value of any Number propounded; hence then let it be required to read, or pronounce, this Number, 987,654,321. Firſt, diſtinguiſh by a Point, or Comma, every three places, which unburthens the Memory, and makes the Work the eaſier: The reading, or pronouncing, is thus; Nine hundred eighty ſeven Millions, Six hundred fifty four Thouſand, Three hundred twenty one.

The Table of Notation, in Figures and Letters.

Units.	1	*First*	place.	1	I	18	XVIII	200	CC
Tens.	12	*Second*		2	II	19	XIX	300	CCC
Hundreds.	123	*Third*		3	III	20	XX	400	CD
Thouſands	1234	*Fourth*	place.	4	IIII	21	XXI	500	D
X. *Thouſ.*	12345	*Fifth*		5	V	30	XXX	600	DC
C. *Thouſ.*	123456	*Sixth*		6	VI	40	XL	700	DCC
Millions.	1234567	*Seven.*	place.	7	VII	49	XLIX	800	DCCC
X. *Million*	12345678	*Eight.*		8	VIII	50	L	900	DCCCC
C. *Million*	123456789	*Ninth*		9	IX	59	LIX	1000	M
Thou.Mil.	1234567891	*Tenth*	place.	10	X	60	LX	10000	CIↃ
X *Th.Mil.*	12345678912	*Elev.*		11	XI	89	LXXXIX	50000	IↃↃ
C.*Th.Mil.*	123456789123	*Twelf.*		12	XII	100	C	100000	CM

CHAP. II.

Addition of Whole Numbers.

ADDITION is that by which many Numbers are gathered, or added together, that in the end their Summ, Aggregate, or Total, may be found. In *Addition*, place the Numbers given one above another; that is, Units above Units, Tens above Tens,

Hundreds

Hundreds above Hundreds, and so on, according to the Number of Places given.

Addition of one Denomination.

Let us suppose these two Numbers 5127, and 2561, be given to be added together; set them one under another, as you see in the Margin, and draw a Line under them, as you see; then begin with the Units, and say, 7 and 1 makes 8, which place under 1 and 7; then to the next, being the place of Tens, and say, 6 and 2 makes 8; then to the next place, being the place of Hundreds, and say, 5 and 1 makes 6; then to the last place, or place of Thousands, and say, 2 and 5 is 7, all which subscribe orderly under the Line, as you see: So is the Work finished, whose Summ amounteth to 7688, as appears by the Work in the Margin.

5127
2561
7688

But these three Numbers be given to be added together, *viz.* 9532, and 7069, and 557; place them down as before is taught, and if any of the Ranks exceed Ten, write down the Excess, and for the odd Ten keep 1 in your Mind; so 7, 9, and 2, makes 18; so is the Excess above 10, 8, so I write down 8, and the 1 that I have in my mind I carry to the next Rank; so 1 that I keep in my mind, and 5, 6, and 3, makes 15; so 5 being the Excess above 10, I write it down under the same Rank, and for the 10, I carry 1 in my mind, as before; then again, 1, and 5, and 5, makes 11; so 1, being the Excess above 10, I write down 1, and carry 1 for the 10, as I said before; so 1, 7, and 9, makes 17, it being the last Number, I write it down orderly under the Line: So doth the whole Summ amount to 17158.

9532
7069
557
17158

And if any Number be given, that the first Rank exceeds 10, 20, 30, 40, 50, 60, or any other Number of Tens, write down the Excess above, or more than the Tens; and for so many Tens as there is in number above the Excess, so many Units carry in your Mind to the next Rank of Figures; and so may you proceed from one Rank to another, till you have compleated your whole Work, as each particular Example following directs.

EXAMPLES.

90527	277853	7590324	7538216
18631	799472	7654031	1978194
25978	973934	9561987	8657327
863	879915	9819751	1472961
135999	2930174	34626093	19646698

Thus far of Addition of Numbers of one Denomination: In the next place, I shall briefly shew, how Numbers of divers Denominations may be added together; as Pounds, Shillings, Pence, and

and Farthings; Years, Months, Days, and Hours; and Signs, Degrees, Minutes, and Seconds: In all which obſerve; Firſt, To write down the Numbers given, orderly one under another; Secondly, In all which begin with the Leſſer Denomination, as in Pounds, Shillings, Pence and Farthings, which is Farthings, four whereof makes one Penny; ſo that what that Rank exceeds in Farthings above the Number of Pence, write down the Exceſs, or Farthings over and above, and carry the Number of Pence to the next Rank; then 12 Pence makes one Shilling, what that Rank exceeds the Number of Shillings, write down the Exceſs in Pence, and carry the Shillings to the next Rank, *viz.* the Rank of Shillings; ſo what that Rank exceeds in Shillings above the Number of Pounds therein contained, place under the ſame Denomination, and carry the Pounds to the laſt Rank, which being added thereto, and becauſe it being the laſt Rank, place its Reſult under its own Denomination accordingly, which concludeth the whole Work. So likewiſe in Addition of Signs, Degrees, Minutes, and Seconds, begin with the leaſt Denomination, which is Seconds, 60 whereof makes one Minute, and 60 Minutes one Degree, and 30 Degrees one Sign, and 12 Signs one Great Circle. Again, in adding Years, Months, Days, and Hours, whoſe leſſer Denomination is Hours, 24 making one Day Natural, 28 Days one Month, and 12 Months one Year. Examples of all which follow.

EXAMPLES.

Addition of divers Denominations.

l.	*s.*	*d.*	*f.*	*y.*	*m.*	*d.*	*h.*	*ſ.*	*d.*	*m.*	*ſ.*
20	15	06	03	15	11	20	16	11	20	42	31
7	12	10	00	50	09	13	10	9	11	15	51
19	07	01	01	75	10	18	08	10	09	56	41
37	19	11	02	10	05	07	19	5	29	10	02
85	15	05	02	153	01	04	05	01	11	05	05

So likewiſe in Weights and Meaſures, obſerve the particular Denominations, and you cannot err, if what before is treated of be rightly underſtood.

CHAP.

CHAP. III.

Substraction of Whole Numbers.

SUBSTRACTION of Numbers is, that one Number being taken out of another, to the end that a Remainder, or Difference may be known. That Number the Substraction must be made from, is to be greater than your other Number; and for placing the Numbers in *Substraction*, it is the same as is before taught in *Addition*.

Substraction of one Denomination.

Let this Number 87562, be given to be Substracted from 198765, place them one above another, as you are before directed, placing your greatest Number uppermost, otherways your Substraction cannot be made; then begin your Substraction, and say, 2 from 5, and there remains 3, which write down under the Line in the same Rank; then to the second Rank, and say, 6 from 6, and there remains nothing, so place 0 under the Line in the same Rank; then proceed to the next, and say, 5 from 7, and there remains 2, which place under the Line, as before; Then proceed to the fourth place, and say, 7 from 8, and there remains 1, which place orderly under the Line; then to the fifth place, and say, 8 from 9, and there remains 1, which subscribe orderly under the Line; then in the last place, subscribe 1 under the Line, because there is no Figure under it, to take from it; and so is the Work finished, whose Remainder, or Difference is found 111203.

198765
87562
111203

Again, let it be required to Substract one Number out of another; when the Figures of the under Numbers are greater than those placed over them, in such a case you must borrow 10 of the next Rank towards the Left-hand, and add it to the Figure above, which makes the Figure more by 10 than it is of it self; and for the 10 that you borrowed, keep 1 in your Mind, which add to the next Number given to be Substracted, and Substract all out of the Numbers above, till the Work be finished.

EXAMPLE.

It is required to Subſtract 6792, from 35671; begin then with the place of Units, and ſay, 2 from 1, which cannot be, wherefore borrow 10 of the next Rank, and add it to 1, which makes it 11; then ſay, 2 from 11, and there remains 9, which note down under the ſame Line; and for the 10 which I borrowed, I carry an Unit (or one) in my Mind, and add it to the next Figure, namely 9, then 9 and 1 is 10; then ſay, 10 from 7, that I cannot have, then I muſt borrow 10 of the next Rank, as before, and add it to 7, which makes 17, then take 10 from 17, and there remains 7; then again, 1 that I have in my Mind, add to the next Figure 7, which makes 8; then ſay, 8 from 6, which cannot be, borrow 10 as before, and add it to 6, which maketh 16; then ſay, 8 from 16, there remains 8; then for the 1 I have in my Mind, I add it to 6, which makes it 7; then ſay, 7 from 5, which I cannot have, then borrow 10 as before, and add to it, which makes it 15; then ſay, 7 from 15, and there remains 8; then for the 1 I have in my Mind, having no Figure to add it to, I Subſtract it from the next Figure 3, and the Remainder is 2: Thus the Work being finiſhed, the Remainder, Difference, or Number ſought, is found to be 28879.

35671
6792
28879

I have here added three Examples anſwerable to thoſe three in *Addition*, which is ſufficient to inform, or inſtruct any truly Ingenious in this matter.

EXAMPLES.

Subſtraction of divers Denominations.

l.	*s.*	*d.*	*f.*	*y.*	*m.*	*d.*	*h.*	*ſ.*	*d.*	*m.*	*ſ.*
79	17	10	02	97	02	15	20	9	21	50	23
51	18	11	03	15	10	16	23	7	23	51	30
27	18	10	03	81	03	26	21	1	27	58	53

So likewiſe in Weights and Meaſures obſerve the particular Denominations, and you cannot err, if the former part of the Chapter be rightly underſtood.

CHAP.

CHAP. IV.

Multiplication of Whole Numbers.

MULTIPLICATION is that which teacheth us by having two Numbers given, to find a third. Of the 2 Numbers given in *Multiplication*, the greater ought to be placed uppermost, and is call'd the *Multiplicand*, and the Number placed under the *Multiplicand*, is call'd the *Multiplicator*, the Number produced by these two, is call'd the *Product*.

Multiplication of one Figure.

Let it be required to multiply 324 by 2; the same order is to be observed in placing your Numbers as in *Addition*; which done, with a Line under them, proceed to your Multiplication, and say, 2 times 4 makes 8, which place under the Line in the same Rank; this done, say again, 2 times 2 makes 4, which place orderly under the Line; then again, two times 3 is 6, which place under the Line as before, so the Product of this Multiplication is found to be 648; and here you must understand, that if your Multiplicator had consisted of more Figures than one, you should have wrought after the same manner, placing them orderly under the same Rank, and so on to the Left-hand till the Work be finished; but if your Number given to be multiplied, when the Product of each particular Figure exceed 10, keep 1 in your Mind; or if the Excess be above 20, write it down, and keep 2 in your Mind, if above 30, keep 3 in your Mind, *&c.* which is to be added to the next Rank.

```
324 Multiplcand.
  2 Multiplicator.
---
648 Product.
```

EXAMPLE.

Multiplication of divers Figures.

Let it be required to multiply 5762 by 45, place them as before, and as in this Example, and begin with the first Figure towards the Right-hand, *viz.* 5, saying, 5 times 2 makes 10; now because the Excess above 10 is nothing, I write a Cypher 0 under the Line in the same Rank, and for the 10 keep 1 in your Mind; then say again, 5 times 6 makes 30, to which if I add 1 that I kept in my Mind, it makes 31, so 1 being the Excess above 30, I write down 1 under the Line in the same Rank, and for the three Tens keep 3 in Mind; again, say 5 times 7 is 35, to which I add 3, which I kept

```
  5762
    45
------
 28810
23048
------
259290 Product.
```

kept in my Mind, the whole is 38, so 8 being the Excess above 3 Tens, which I put orderly under the Line, and keep 3 Tens in Mind; then again, say 5 times 5 is 25, to which if I add the 3 I kept in my Mind, the Number is 28; and because it is the last, I write down the whole Sum of 28 under the Line, so the single Product arising from 5, is 28810: Then begin with the next Figure of your Multiplicator, *viz.* 4, and proceed to multiply as before, saying, 4 times 2 makes 8, which place under the Line, and under 4 being the same Rank; then again say, 4 times 6 is 24, so 4 being the Excess above 2 Tens, I put down 4 under the Line, and keep 2 in my Mind for the 2 Tens; again 4 times 7 is 28, to which add 2 I kept in Mind, and it makes 30, the Excess being nothing, I write 0 under the Line, and for the 3 Tens keep 3 in Mind; then say, 4 times 5 is 20, to which add 3 I kept in Mind, the Sum is 23, it being the last of my *Multiplication*, I write it down under the Line towards the Left-hand, which Product is 23048, which two Sums added together, produceth the mean Product 259290: And thus may you multiply by as many Figures as Necessity requires.

CHAP. V.

Division of Whole Numbers.

DIVISION teacheth to find out how many times one Number, or Sum, is contain'd in another, or to divide any Number into as many equal parts as shall be required.

There are three remarkable Numbers in *Division*, *viz.* the *Dividend*, the *Divisor*, and the *Quotient*; the Dividend is that Number which is given to be divided, the Divisor is the Number by which the Dividend is to be divided, the Quotient is the Number that ariseth from the Division.

Division by Single Figures.

576	*Dividend.*
4	*Divisor.*
17	
4	(144 *Quot.*
16	
16	
4	
16	
00	*Remainder.*

Let us for the first *Example* divide 576 by 4, write down your Numbers as in the Margin, and ask how often you can have the Divisor 4 in 5, which is the first Figure of your Dividend, which can be had but once, which place behind the crooked Line for the first Figure in the Quotient, then multiply the Divisor by the Figure placed in the Quotient, and write the Product under the Dividend, from which it must be Substracted; so 4 multiplied by 1 is 4, which Substract from 5, the Remainder is 1; draw a Line under your

Divisor, and place your Remainder 1 orderly under the Line, then transcribe the next Figure of your Dividend, which is 7, and place your Divisor orderly under it; then ask how often your Divisor 4 is contain'd in your new Dividend 17, which being 4 times, which 4 place behind 1 in the Quotient, then multiply your Divisor 4 by 4, the last Figure placed in the Quotient, and the Product is 16, which Substract from 17, the Remainder is 1, which place under the Line as in the Example; then transcribe 6, the last Figure of your Dividend, so have you another new Dividend, to which bring down 4 your Divisor, and ask how often it is contained in 16 your new Dividend, which is 4 times, which four place in the Quotient, and multiply it by your Divisor 4, and the Product is 16, which Substracted from your new Dividend 16, and the Remainder is 0, thus the whole Work is finished, and the Quotient found to be 144; see the whole Operation in the Margin: And this is call'd single Division, because the Divisor is but one Figure, but when the Divisor consists of more Figures than one, the Work is more difficult than the former, but being well instructed in the former, the following will be more readily apprehended.

Division by Several Figures.

Let us suppose this Number 52063 to be given to be divided by 232; in placing your Numbers you are to observe, that if your Divisor be greater than the same number of Figures of the Dividend above it, then remove your Divisor one Figure towards the Right-hand, and then the Work will be the same with the following: Your Numbers being placed as before directed, make a Crooked Line on the Right-hand of your Dividend, to place your Quotient in, then proceed to your Work, and ask how often 232 may be taken out of 520, or ask how often 2, the first Figure of your Divisor, may be taken out of 5, the first Figure of your Dividend, which in this *Example* is found twice, which 2 place behind the Crooked Line, for the first Figure in the Quotient; then Multiply 232 the Divisor, by the Figure placed in the Quotient, and the Product of that Multiplication will be 464, which place under the Divisor, and draw a Line under them; then Substract 464 from 520, (the three first Figures of your Dividend) the Remainder is 56, which place orderly under the Line: This done, the next Figure of your Dividend, is to be placed on the Right-hand 56, so will your Number be 566, for a new Dividend: Then place down your Divisor under 566, your new Dividend, and Work as before, asking how often 232, may be taken out of 566, or rather, 23 out of 56, or 2 out of 5, which in this *Example* can only be taken twice: Place 2 in

```
52063
232
464
-----
 566
 232   (224 95/232
 464
-----
 1023
  232
  928
-----
   95
```

 the

the Quotient, then as before, Multiply the Divisor by the Figure last placed in the Quotient, and the Product is 464, which Substract from 566 (your Dividend) and the Remainder is 102; then bring down 3, the last Figure of your first Dividend, to the Remainder 102, so will the Number be 1023 for another new Dividend; then as before, place down your Divisor orderly under the new Dividend: Now because the new Dividend consists of one place more than is in the Divisor, it must be asked, How often the first Figure of your Divisor, is contain'd in the two first Figures of the new Dividend 10, which may be had five times; but because the next Figure of your Divisor cannot be taken so many times out of the Figure above it, I must take a less Number, which let be 4, which write in the Quotient: Then again Multiply your Divisor by 4, and the Product is 928, which is to be Substracted from 1023, and the Remainder is found 95, which is so many parts of the Divisor: The whole Operation being finished, the Quotient sought, is found $224\frac{95}{232}$.

Division and *Multiplication* do always prove one another: In *Division* Multiply the Divisor by the Quotient, and add the Remainder to the Product, the Sum will be the same with the Dividend.

To prove *Multiplication*, divide your Product by your Multiplicator, and the Quotient produceth the Multiplicand.

CHAP. VI.

The Rule of Three Direct.

The Single Rule of Three Direct.

THE *Rule of Three*, which for its Excellency, is term'd the *Golden-Number*, and by many (and that properly) call'd, the *Rule of Proportion*; for having Three Numbers given that are known, it teacheth to find out a Number unknown in proportion to them; and this Rule is performed by *Multiplication* and *Division*: For by Multiplying the second Number into the third, or third into the second, which is all one, the Number thence arising divide by the first Number, so is the Quotient the fourth Number required: So if 6 Foot of Board cost 12 *d.* what shall 9 Foot cost? In this *Rule of Three Direct*, the fourth Number that is sought, is to have such Proportion to the second, as the third hath to the first, in the former Question; the fourth Number is to have such Proportion to 12, as 9 hath to 6. Hence, by this

```
f.   d.    f.   d.
6 : 12 :: 9 : 18
      9
    ---
    108 Product.
      6 Divisor.
    ---
    48
     6 (18 Quotient
    48
    ---
    00 Remainder.
```

this Analogy, we say, as 6 is to 12, so is 9 to the fourth Number required. In the placing of your Numbers, you are to observe to place them as they are propounded; then Multiply the second Term by the third, *viz.* 12 by 9, and the Product is 108, which divide by 6, the first Term, and the Quotient is 18, the fourth Number found as was required: See the Work in the Margin, and this is the *Rule of Three Single.*

The Rule of Three Compound.

The *Rule of Three Compound*, is when any of the Numbers propounded are of several Denominations, as Acres, Roods, and Perches; Pounds, Shillings, and Pence; or Days, Hours, and Minutes; or Yards, Feet and Inches: If they be of two or three Denominations, they must first be reduced to the least Denomination propounded.

EXAMPLE.

If 5 Yards 8 Foot of Painting cost 8 Shillings, what shall 4 Yards cost? Here the first Term is of two Denominations, *viz.* Yards and Feet, it must therefore be reduced to the least Denomination, because they express things of different Names, *viz.* Shillings into Pence, and Yards into Feet: The first Number given is 5 Yards 8 Feet, which according to the Rules of *Reduction*, will be reduced into 53 Feet, so accordingly will 8 Shillings be reduced into 96 Pence; so likewise will the third Term, 4 Yards, be reduced into 36 Feet; these three Numbers being thus reduced to the least Denominations, the Working it will be the same with the former, and the Numbers are to be placed as in the former Example; which done, proceed to the Work, Multiplying 96 by 36, the Product is found 3456. which divide by 53, the first Term, and the Quotient is 65 Pence, and somewhat more, but it being less than a Farthing, we omitted it as useless.

$$
\begin{array}{rrl}
53 : & 96 :: 36 : 65 & \\
 & 36 & \\
\hline
 & 576 & \\
 & 288 & \\
\hline
 & 3456 & \textit{Product.} \\
 & 53 & \textit{Divisor.} \\
 & 318 & \\
\hline
 & 276 & (65\ \textit{Quot.} \\
 & 53 & \\
 & 265 & \\
\hline
 & 11 & \textit{Remainder}
\end{array}
$$

The Rule proved.

The Proof of this Rule: Multiply the fourth Term by the first, and if the Product be equal to the Product of the second and third Term Multiplied, the Work is right, otherways not; and if there happen to be any thing remain after the Work is finished, it is to be added to the Product of the first and fourth Terms Multiplied, and that Sum will be equal with the Product of the second and third Term.

CHAP. III.

The Rule of Inverſe.

IT will not be amiſs firſt to ſhew the Difference betwixt this and the former Rule, and when this, and when the former are properly to be uſed: Hence obſerve, if more require more, or leſs require leſs, then the former *Rule of Three Direct* is to be uſed; but if more require leſs, or leſs require more, then uſe this Reverſe Rule.

This Reverſe Rule is wrought contrary to the former; for in this Multiply the firſt Term by the ſecond, and divide the Product by the third, ſo is the Quotient the deſired Number: I ſhall inſtance only in one Example, as followeth.

If 20 Maſons perform a certain Piece of Walling in 12 Days, how many Workmen ſhall do the ſame in 4 Days? Place your Numbers as here in the Margin, then Multiply the firſt Term by the ſecond, or ſecond by the firſt, which is all one, *viz.* 20 by 12, the Product is 240, which divide by 4, the Quotient is 60, the Number required.

Days		*Men*		*Days*		*Men*
12	:	20	: :	4	:	60

```
   12
  ----
   40
   20
  ----
  240    Product.
   4   (60 Quotient.
   24
  ----
   00
```

I ſhall not add any more Examples, ſince this is only the Converſe of the former; for it will be eaſie (if what before is ſaid be rightly underſtood) to any truly Ingenious, to conſider the State of the Queſtion, and conſequently by which of the foregoing Rules it is to be ſolved by.

To prove this Inverſe Rule, Multiply the third Term by the fourth, which ſhall be equal to the firſt and ſecond Term Multiplied.

CHAP. VIII.

The Extraction of the Square-Root.

THE Extraction of the *Square-Root* is by having a Number given, by which we may find the Number ſought, by Multiplying the given Number in it ſelf.

Let it be required to Extract the *Square-Root* out of 1296; to prepare your Number for Extraction, ſet over the Figure 6 a Prick, and upon the third next to it another Prick thus, $\dot{1}2\dot{9}6$; and if the Number

Number had consisted of more Places, it is but placing over every third Figure, a Prick, or Dot, to the end of your Number, always leaving one Figure betwixt two Pricks; and as many Pricks as there is put over the Figures, so many Figures must there be in the Quotient; then proceed and take out the Root of 12, which is 3, and place it in the Quotient; then subscribe the Square of the Figure placed in the Quotient under the first Square of the Number given, *viz.* 9 under 12, from which it is to be Substracted, and place the Remainder 3 orderly under the Line; then to the said Remainder bring down 96, so this Square 96 being placed next to the Remainder, the Sum will be 396, which we call the Resolvend; then double the Root, and place it before a Crooked Line on the Left-hand the Resolvend, which is to be a Divisor; the double of the Root is 6, then must the Resolvend be a Dividend, all but the first Figure towards the Right-hand, to wit, the place of Units: Then ask how often 6, your Divisor, may be taken out of 39 the Dividend, which may be had 6 times, which place in the Quotient, and also betwixt the Divisor and the Crooked Line: This done, Multiply all the Number on the Left the Resolvend, by the Figure last placed in the Quotient, and place the Product orderly under the Resolvend; so 66 Multiplied by 6, the Product is 396, which Substract from the Resolvend, the Remainder is nothing: And thus is the Work finished, the Root being found just 36.

$$
\begin{array}{rll}
 & \dot{1}2\dot{9}6 & \\
 & \underline{9} & \\
 & 396 & \textit{Resolvend.} \\
66) & \underline{396} & \text{(}36\ \textit{Root.} \\
 & 000 & \textit{Remainder.}
\end{array}
$$

If after the Work is done, any Fraction remain, you may add (either at first, *viz.* to the Number given, or to the Remainder) a convenient Number of Pairs of Cyphers, and then Work according to the former Directions; and so many Points as was placed over the whole Number, so many whole Numbers will be in the Root, the rest towards the Right-hand will be the Numerator of a Decimal Fraction, which will consist of as many Places as there were Pricks over the Cyphers, which Numerator will be so many parts of 10, 100, 1000, 10000, *&c.* which is easily discovered thus: If the Numerator of the Decimal Fraction be but one Figure, it is so many parts of 10, if two, it is so many parts of 100, *&c.*

CHAP. IX.

The Extraction of the Cube-Root.

THE Extraction of the *Cube-Root*, is, that by having a Number given, and another Number is found, which being Multiplied in it self, and then by the Product that ariseth, produceth the Number required.

Let it be required to Extract the *Cube-Root* out of 17576: Set a Point upon the first Figure towards the Right-hand, *viz.* upon 6, then another Prick upon the fourth Figure 7, and to the end of the Sum, always leaving betwixt every two Pricks, two Figures; and as many Pricks as there are so made, so many Figures must be in the Quotient: Then begin and find the *Cube-Root* of 17, which is 2, for 2 times 2 is 4, and 2 times 4 is 8; if I had taken 3 it had been too much; for 3 times 3 is 9, and 3 times 9 is 27, which exceeds the first Cube 17; therefore take always the next lesser Number: But to our present Example, draw a Crooked Line on the Right-hand the Number propounded, and place the Root of 17, which is 2 behind the said Crooked Line; then subscribe the Cube of the Root placed in the Quotient, which was found 8, under 17, the Cube-Number given; the Numbers thus placed with a Line under them, Substract 8 from 17, and the Remainder is 9, which place orderly under the Line; then to the said Remainder 9, bring down the next Cube of the Number given, which is 576, which makes 9576, which call a Resolvend; next the Root in the Quotient is to be Squared, that is, Multiplied in it self, which makes 4, the Triple whereof is 12, which is to be subscribed under the Resolvend, in such manner that the first Figure of the Triple Square, *viz.* the place of Units, is to be placed under the Hundreds in the Resolvend; then triple the Root in the Quotient, and place the Triple thereof under the Resolvend, in such manner as the place of Units may stand under the place of Tens in the Resolvend; then place the Triple of the Root 2, which is 6, under 7, the place of Tens in the Resolvend; which done, draw a Line under them, and add them together in such order as they are placed, which makes 126, which Number is to be a Divisor; then let the Resolvend only, the first Figure towards the Right-hand, be a Dividend, (*viz.* the place of Units;) then ask how often the Figures of your Divisor may be taken out of the Figures of the Dividend, and place the Answer in the Quotient: Thus by the

```
 ·  ·
17576
 8
-----
 9576   Resolvend.
 12
   6
-----
 126    (26 Quotient.
-----
 72
 216
  216
-----
 9576
-----
 0000   Remainder.
```

Rules

Rules of *Division*, 126 the Divisor, may be taken out of 957, the Dividend, 6 times; so I place 6 in the Quotient, and draw a Line under the Divisor: Then Multiply 12, the Triple Square, by 6, the last Figure placed in the Quotient, and place the Product 72, under 12, the Triple Square: Then Multiply the Figure last placed in the Quotient, first by it self, and then by the Triple Number before subscribed, placing this Product under the Triple Number; so 6 Multiplied first in it self, produces 36, which Multiplied by the Triple Number 6, the Product is 126, which place under the Triple Number, (*viz.* Units under Units, Tens under Tens;) this done, Cube the Figure last placed in the Quotient, and subscribe the Cube under the Resolvend in such manner, that the first place of the Cube, *viz.* the place of Units, may stand under the place of Units in the Resolvend; so the Cube of 6, is 216, which place under the Resolvend as I said before: These three, *viz.* 72, 216, 216, thus placed, draw a Line under them, and add them together as they are placed, which Sum amounteth to 9576, which Substracted from the Resolvend, the Remainder is 0. The whole Work being finished, the *Cube-Root* of 17576, is found to be 26.

If any Fraction at any time remain after the Work is done, annex a convenient Number of Ternaries of Cyphers to the first Number given, then esteeming it one intire Number, the Work is to be performed according to the preceding Rules; and so many Points as were placed over the Whole Number given, so many Whole Numbers will be in the Root: The rest towards the Right-hand will be a Fraction, as I have shewed in the Extraction of the *Square-Root*.

CHAP. X.

Reduction of Fractions.

RULE I. *To find the Common Measure.*

```
18) : 66 : (3
      54
      --
     12) 18 (1
         12
         --
        6) 18 (3
           18
           --
            0
```

TO find the Common Measure of two given Fractions, Divide the greater by the lesser, and the Divisor by the Remainder; so do continually till nothing remains, so is the last Divisor the Common Measure sought: See the Example in the Margin, *viz.* 66 and 18 being the Numbers given, to find the greatest Common Measure belonging to them, which according to the former Directions, is found to be 3, as the Example plainly demonstrates in the Margin.

Rule II. *To Reduce Fractions to their least Terms.*

Let us suppose the aforesaid Numbers, 66 and 18, were given to be reduced to lesser Terms: Divide 66 and 18 by 3, (the Common Measure to both Numbers found by the former Rule) and the Quotients are 22 and 6, so that $\frac{18}{66}$ is Reduced to $\frac{6}{22}$.

Again: Suppose $\frac{55}{240}$, were given to be Reduced to their least Terms, still keeping the same Proportion, whose Common Measure, by the first Rule, is found to be 11; by which dividing 240, the Denominator given, and it gives a new Denominator 22: So likewise divide the Numerator 55 by 11, the Quotient is 5 for a new Numerator; so is $\frac{55}{240}$ Reduced to $\frac{5}{22}$, but where both the given Fractions end with 5 or 0, or one with 5, the other with a Cypher, then 'tis but dividing either Number by 5. As if 240 be divided by 5, the Quote is 48, and the Quotient of 55, divided by 5, is 11, so $\frac{11}{48}$, is in Proportion to $\frac{5}{22}$, or $\frac{55}{240}$.

Rule III. *To Reduce Vulgar Fractions to Decimals.*

To Reduce Vulgar Fractions to Decimals. Multiply the Numerator given, by the Denominator required, and divide the Product by the Denominator given.

Let it be required to Reduce $\frac{5}{8}$ of a Pound, Perch, Yard, Foot, *&c.* to Decimals whose Denominator is 1000: Multiply 5, the Numerator given by 1000, the Product is 500, which divide by the Denominator 8, the Quotient is $\frac{625}{1000}$, the Decimal required: See the Example in the Margin.

```
           1000
              5
           ----
           5000
*Divis.* 18)  48
           ----
             20 (625 Q.
             16
           ----
             40
             40
           ----
             00
```

Again: Suppose $\frac{10}{15}$ of a Perch, Yard, *&c.* were given to be Reduced to the known parts of a Decimal, whose Denominator is 100, which Multiply and Divide according to the former Directions, so will the Vulgar Fraction of $\frac{10}{15}$, be Reduced to the Decimal of $\frac{66}{100}$.

Rule IV. *Reduction of Compound Fractions.*

Compound Fractions, or Fractions of Fractions, before they can be worked up, must be Reduced into Single Fractions: As suppose these Fractions $\frac{2}{3}$ of $\frac{3}{5}$ of $\frac{5}{8}$ were given to be Multiplied, or Divided by $\frac{2}{6}$ of $\frac{3}{4}$, which must first be Reduced to a Single Fraction thus: Multiply all the Numerators continually for a new Numerator; and Multiply all the Denominators continually for a new Denominator, thus; 2 times 3 is 6, and 6 times 5 is 30, for a new Numerator; then 3 Multiplied by 5, makes 15, which 15 Multiplied by 8, makes 120, for a new Denominator; so are these

Fractions Reduced to $\frac{30}{120}$, and by the ſame Rule the other Fractions will be Reduced to $\frac{6}{24}$, which are thus fitted either for *Addition, Subſtraction, Multiplication,* or *Diviſion.*

RULE V. *Reduction of Improper Fractions to Proper, with Whole, or Mixt Numbers.*

To bring an Improper Fraction into its Equivalent, either Whole, or Mixt Numbers, do thus: Divide the Numerator by the Denominator, ſo will the Quotient give the Whole, or Mixt Number ſought.

EXAMPLE.

Let this Improper Fraction $\frac{51}{14}$, be given to be Reduced into this Mixt Number $3\frac{9}{14}$; for if 51 be divided by 14, the Quotient is $3\frac{9}{14}$, the thing required. Likewiſe this Improper Fraction $\frac{55}{8}$, will be Reduced to $6\frac{7}{8}$.

RULE VI. *Reduction of Fractions to a Common Denominator.*

If Fractions have unequal Denominators, they muſt be reduced to Fractions, which ſhall have equal Denominators, which is thus performed, *viz.* Multiply the Numerator of the firſt Fraction, by the Denominator of the ſecond; ſo will the Product be a new Numerator of that firſt Fraction; then Multiply the Numerator of the ſecond Fraction, by the Denominator of the firſt, ſo the Product is a new Numerator of the ſecond Fraction; and laſtly, Multiply the Denominators one by the other, and that Product is a common Denominator to both the Numerators.

EXAMPLE.

Suppoſe theſe Fractions $\frac{3}{4}$ and $\frac{4}{6}$, be the Fractions propounded; Multiply 3 by 6, the Product is 18, for a new Numerator common to 3; likewiſe Multiply 4 by 4, the Product is 16, for a new Numerator common to 4; then Multiply the Denominators together, *viz.* 4 by 6, the Product is 24, for a new Denominator common to both the New Denominators: Obſerve the Work in the Margin, which explains the whole Matter.

$$\begin{array}{ccc} 3 & & 4 \\ & \mathbf{X} & \\ 4 & & 6 \\ \hline 16 & & 18 \\ \hline 24 & & 24 \end{array}$$

RULE VII. *Reduction of Mixt Numbers to Improper Fractions.*

Multiply the Integer, or Integers in the Mixt Number, by the Denominator of the Fraction ſo joyned to the Integer; and to that Product add the Numerator of the ſame Fraction, and that Sum is the Numerator of an Improper Fraction, whoſe Denominator is the ſame it was without any alteration.

EXAMPLE.

Five $\frac{13}{15}$ will be Reduced to the Improper Fraction $\frac{88}{15}$; for if 15 the Denominator, be Multiplied by 5 the Integer, the Product is 75, to which add 13 the Numerator, the Sum is 88, which place over the Denominator 15. According to the former Method 20 $\frac{31}{30}$ will be Reduced to the Improper Fraction of $\frac{631}{30}$.

RULE VIII. *To find the true Value of a Single Fraction.*

To find the true Value of a Single Fraction in its known Terms, or Parts of its Proper Integer, is only Multiplying the Numerator of the Fraction propounded, by the Denominator proposed, and Divide that Product by the Denominator given, and if a Fraction still remain, find the Value thereof in the next Inferiour Denomination.

EXAMPLE.

To find the Value of $\frac{8}{16}$ of a Pound Sterling: Multiply 8, the Numerator, by 20 the next Inferiour Denomination, and the Product is 160, which Divide by 16, the given Denominator, the Quotient is 10 Shillings.

Again: Suppose $\frac{9}{16}$ of a Pound were given, 9 Multiplied by 20, the Product is 180, which divided by 16, the Quotient is 11 $\frac{4}{16}$, which Remainder 4 Multiply by 12 Pence, the next Inferiour Denomination, the Product is 48, which divided by 16, gives 3 Pence in the Quotient; so that $\frac{9}{16}$ of a Pound is brought to its known parts, *viz.* 11 *s.* 3 *d.* Observe the same by Weights and Measures.

CHAP. XI.

Numeration of Vulgar Fractions.

A FRACTION, or Broken Number, is part of a Whole Number, or Integer, as may be thus expressed: If you measure the Length of any Superficies that contains three Fourths, or three Quarters of a Yard, you are to express it thus $\frac{3}{4}$, because a Yard is supposed to be divided into four equal Parts, also a Foot divided into 12 equal Parts, call'd Inches; write four Inches thus $\frac{4}{12}$, that is, four 12 Parts of a Foot; but if the Foot be divided into 100 equal Parts, the Fractional part may be thus expressed; $\frac{36}{100}$; that is, 36 parts of a Foot.

But here you are to take notice for the Terms of the Fractions; that which is placed above the Line, is call'd the Numerator, and

and the Number under the Line, is call'd the Denominator, as in the last Example, 36 being the Numerator, and 100 the Denominator.

CHAP. XII.

Addition of Vulgar Fractions, and Mixt Numbers.

RULE I.

IF Single Fractions be given to be added, and have their Denominators all alike, or of one Denomination; then 'tis but adding all the Numerators together, which Sum is to be placed over the Common Denominator, and the Work is done: So if $\frac{2}{9}$, and $\frac{3}{9}$, $\frac{1}{9}$, and were given to be added, their Sum would be found $\frac{6}{9}$.

RULE II.

If the Fractions given to be added, have unequal Denominators, then must they be Reduced to the same Value by the Sixth Rule of *Reduction*; then is the Addition the same with the former.

EXAMPLE.

Suppose $\frac{3}{5}$ and $\frac{4}{6}$ were given to be added, which by the Sixth Rule of *Reduction*, will be Reduced to $\frac{18}{30}$ and $\frac{20}{30}$, which is added, as in the First Rule, makes $\frac{38}{30}$; now because the Numerator is greater than the Denominator, it is an Improper Fraction, and to be Reduced by the Fifth Rule of *Reduction*, which brings it to this Mixt Number $1\frac{8}{30}$, the thing required.

RULE III.

When Mixt Numbers are given to be added, first find the Sum of the Fractions, as is taught in the two former Rules; then add the Integers (if any be) in the Sum of the Fractions, to the Whole Numbers, and then add them as Whole Numbers.

EXAMPLE.

Suppose $4\frac{2}{3}$, and $5\frac{4}{5}$, be given to be added: First, by the Sixth Rule of *Reduction*, the Fractions are Reduced to one Common Denominator, and stand thus, $\frac{10}{15}$, $\frac{12}{15}$, which added, is $\frac{22}{15}$, being now an Improper Fraction, which by the Fifth Rule of *Reduction*, is

brought to $1\frac{7}{15}$; which added to 4 and 5, the Whole Numbers makes $10\frac{7}{15}$, the thing required.

Again, If $5\frac{2}{4}$, and $10\frac{3}{7}$; by the former Rules, will he found $15\frac{26}{28}$.

Rule IV.

If ſeveral Fractions be to be added, as $\frac{3}{8}$, $\frac{2}{5}$, $\frac{5}{7}$: Firſt, Multiply continually the firſt Numerator into the ſecond and third Denominators 5 and 7, ſaying, 3 times 5, is 15, and 7 times 15, is 105, for a new Numerator proper to 3. Secondly, Multiply continually the Numerator 2, into the firſt and third Denominator 8 and 7, ſaying, 2 times 8, is 16, and 7 times 16 is 112, being a Numerator proper to 2. Thirdly, Multiply continually the third Numerator 5, into the firſt and ſecond Denominators 8 and 5, ſaying, 5 times 8 is 40, and 5 times 40, is 200, for a new Numerator inſtead of 5. Laſtly, Multiply all the Denominators continually one into another, *viz.* 8 by 5, which makes 40, and 40 by 7, which makes 280, which is the Common Denominator, as followeth, *viz.* $\frac{105}{280}$, $\frac{112}{280}$, $\frac{200}{280}$. Hence always obſerve this General Rule in finding the new Numerators; Always miſs the Denominator, in your Multiplication of its own Numerator, and then you cannot fail. See the Example.

5	8	8	8
3	2	5	5
15	16	40	40
7	7	5	7
1ſt *Numer.* 105	2d *Numer.* 112	3d *Numer.* 200	*Denomina.* 280

Then the Numerators being all added, make 417, which place over 280, the Common Denominator, thus, $\frac{417}{280}$; which by the Fifth Rule of *Reduction*, is brought to this Mixt Number $1\frac{137}{280}$, the thing required.

CHAP. XIII.

Subſtraction of Vulgar Fractions and Mixt Numbers.

Rule I.

If the Fractions be both Single, Subſtract the leſſer Numerator from the greater, and place the Remainder of the Fraction over the Common Denominator.

EXAM-

EXAMPLE.

The Difference betwixt $\frac{7}{14}$, and $\frac{6}{14}$, is $\frac{1}{14}$; alſo the Difference of $\frac{20}{35}$, and $\frac{11}{35}$, is $\frac{9}{35}$; and the Difference between $\frac{46}{120}$, and $\frac{109}{120}$, is $\frac{63}{120}$.

RULE II.

But when the Numbers given are both Single Fractions, and have different Denominators, they are to be reduced to a Common Denominator by the Sixth Rule of *Reduction*, then the Work will be the ſame with the former.

RULE III.

When one of the Numbers given, happen to be a Whole, or Mixt Number, or when both of them are Mixt Numbers, Reduce them to an Improper Fraction by the Seventh Rule of *Reduction*, then is the Work to be performed according to this Firſt Rule.

EXAMPLE.

If $8\frac{4}{6}$ be given to be Subſtracted from 14, the Remainder will be found $5\frac{2}{6}$; for by the Seventh Rule of *Reduction*, $8\frac{4}{6}$, is Reduced to $\frac{52}{6}$, alſo 14 is Reduced to $\frac{14}{1}$; then by the Sixth Rule of *Reduction*, theſe Improper Fractions are Reduced to one Common Denominator of $\frac{52}{6}$, and $\frac{84}{6}$; which Subſtracted, as in the Firſt Rule, gives the Remainder $\frac{32}{6}$; which by the Fifth Rule of *Reduction*, is Reduced to its Proper Mixed Number $5\frac{2}{6}$.

Again, If $10\frac{5}{12}$, be given to be Subſtracted from $20\frac{4}{10}$, the Remainder (according to the former Preſcriptions) will be found $9\frac{118}{120}$. Theſe are all the Caſes that can happen in Subſtraction of Vulgar Fractions, and Mixt Numbers.

CHAP. XIV.

Multiplication of Vulgar Fractions, and Mixt Numbers.

RULE I.

If the Numbers given to be Multiplied, be both Single Fractions, Multiply the Numerators together, ſo is the Product a new Numerator: Likewiſe Multiply the Denominators together, which Product is the new Denominator ſought. So if $\frac{5}{16}$, and $\frac{3}{7}$,

 be

be given to be Multiplied, the Product will be found $\frac{15}{112}$; for 5 Multiplied by 3, produceth 15, for the new Numerator; and 16 Multiplied by 7, gives 112, for the new Denominator: Alſo $\frac{3}{2}$, and $\frac{7}{9}$ Multiplied as before, the Product will be found $\frac{21}{18}$.

Rule II.

But let it be required to Multiply Mixt Numbers, as $324\frac{1}{4}$, by $62\frac{1}{2}$: Firſt Multiply the Whole Numbers, and place the Products orderly, as is taught, in whole Numbers; then Multiply the Fractions into the Whole Numbers croſs ways, *viz.* $\frac{1}{2}$ of 324, is 162; and $\frac{1}{4}$ of 62, is 15 $\frac{1}{4}$, which place as you ſee; laſtly, add them together, and annex the Fractional part $\frac{1}{8}$ to the Product; which done, the Product ſought, is $20265\frac{1}{8}$. But this way in all Caſes of Mixt Numbers, is not ſo preciſely true, as this which follows.

$$\begin{array}{r} 324\frac{1}{4} \\ 62\frac{1}{2} \\ \hline 648 \\ 1944 \\ 162 \\ 15 \\ \hline 20265\frac{1}{8} \end{array}$$

Let us ſuppoſe theſe following Numbers be given to be Multiplied, *viz.* $9\frac{2}{3}$, by 6, a Whole Number, the Product will be found $58\frac{0}{3}$; for $9\frac{2}{3}$ muſt be Reduced by the Seventh Rule of *Reduction*, to the Improper Fraction $\frac{29}{3}$, and 6 to $\frac{6}{1}$, whoſe Numerators 29 and 6, Multiplied together, makes 174, which place over 3 thus, $\frac{174}{3}$; then the Denominators 1 by 3, the Product is 3 for the Denominator: Hence $\frac{174}{3}$ Reduced to its Whole, or Mixt Number, by the Fifth Rule of *Reduction*, is brought to $58\frac{0}{3}$, the Product ſought.

CHAP. XV.

Diviſioon of Vulgar Fractions and Mixt Numbers.

Rule I.

IF the Fractions given be both Single Fractions, Multiply the Denominator of the Diviſor, by the Numerator of the Dividend, and that Product is a new Numerator; alſo Multiply the Numerator of the Diviſor, by the Denominator of the Dividend, the Product is a new Denominator; which new Fraction is the Quotient ſought.

EXAMPLE.

If $\frac{5}{8}$ be given to be divided by $\frac{3}{4}$, the Quotient will be found $\frac{20}{24}$; for 5 Multiplied by 4, is 20, for a new Numerator; and 3 Multiplied by 8, is 24 for the new Denominator.

Again, If $\frac{4}{9}$ be given to be divided by $\frac{2}{6}$, the Quotient will be found $\frac{24}{18}$, which is to be Reduced by the Fifth Rule of *Reduction*, into this Mixt Mumber $1\frac{6}{18}$, the Proper Quotient sought

Rule II.

If any one of the Numbers is a Whole, or Mixt Number, or both happen to be Mixt Numbers, such Whole, or Mixt Numbers, are to be Reduced to an Improper Fraction by the Seventh Rule of *Reduction*, and then the Work will be the same as is taught in the last Rule.

EXAMPLE.

If 19 be Divided by $6\frac{1}{2}$, the Quotient will be found $2\frac{12}{13}$; for $6\frac{1}{2}$ will be Reduced to the Improper Fraction of $\frac{13}{2}$, and 19 to $\frac{19}{1}$, which Divide as in the First Rule, and the Quotient is $\frac{38}{13}$; which by the Fifth Rule of *Reduction*, is Reduced to the Mixt Number $2\frac{12}{13}$, the thing desired. If these Directions be rightly understood, it will be sufficient for all Cases in Fractions, and Mixt Numbers.

$$6\tfrac{1}{2})\quad 19$$
$$\tfrac{13}{2})\quad \tfrac{19}{1}\quad (\tfrac{38}{13}$$
$$2\quad \tfrac{12}{13}\quad \textit{Quote.}$$

CHAP. XVI.

Numeration of Decimals.

WHEN a Single Fraction hath for its Denominator an Unite in the Place on the Left-hand, and if there be nothing but Cyphers towards the Right-hand, it may be termed a Decimal of these kind that follow, *viz.* $\frac{5}{10}$, $\frac{7}{100}$, $\frac{45}{1000}$, $\frac{127}{10000}$; if the Numerators and Denominators both end with Cyphers, it may be Reduced to a less Fraction; as $\frac{100}{1000}$ is reduced to $\frac{10}{100}$, or $\frac{1}{10}$: the like is to be understood of the rest that have Cyphers at the ends of both Numbers.

CHAP. XVII.

Addition of Decimals.

GREAT care of placing Decimal Fractions to be added, is the greateſt Work of this part, which is to place every Number under its proper Denominator; as Whole Numbers, under Whole Numbers, and Tenths under Tenths; adding them together as Whole Numbers, ſeparating the Whole Numbers from the Fractions, as in the following

EXAMPLES.

20.2376	70.104	50.016
15.541	11.9721	1.07
42.7631	56.2379	.8
88.5417	138.3140	51.886

CHAP. XVIII.

Subſtraction of Decimals.

THE ſame Order is to be obſerved in placing the Numbers for *Subſtraction*, as in *Addition*; and the Subſtraction to be made as in Whole Numbers; the Diſtinction of Integers from the Fractional parts being obſerved as in *Addition*. See the following

EXAMPLES.

.962	76.	87.0079	243.271	50.
.771	05.37	.6570	52.310	.760
.191	70.63	86.3509	190.961	49.240

CHAP.

CHAP. XIX.

Multiplication of Decimals.

IN *Multiplication of Decimals*, whether Fractions, or Mixt Numbers, they are to be Multiplied as Whole Numbers; observing so many Places of Fractions as are in both the Multipliers; for so many Figures is to be cut off in the Product towards the Right-hand, for the Fractional part, and those which are on the Left-hand, are Integers, or Whole Numbers; and if the Product do not consist of as many Places as there are Decimals in both Multipliers, then prepare so many Cyphers as shall make that Number up; This may only happen when the Product is a Fraction.

20.15721	.67	412.32
21.3	.0132	51.
429.38573	.008844	21028.32

CHAP. XX.

Division of Decimals.

IN *Decimal-Division* the Dividend must sometimes have Cyphers *Post-poned*, that it may consist of more Decimals than the Divisor, which may be increased at pleasure; and if the Decimals in the Divisor and Quotient, do not amount to those of the Dividend, then *Post-pone* as many Cyphers, as may make them equal: Let the Dividend be 1725, and the Divisor 3.746; then, as I said before, *Post-pone* a convenient Number of Cyphers, that may make way for the Divisor, then the Work will stand thus:

3.746) 172.500000

Then perform the Division as in Whole Numbers, and it stands thus:

3.746) 172.500000 (46049

Now for to separate the Integers from the Decimal Parts, is the Key to unlock the whole Work, which is thus performed, *viz.*

Separate so many Figures from the Quotient towards the Right-Hand, as may make the Decimals in the Divisor, equal to those in the Dividend: Hence I find the Point of Separation falls betwixt 6 and 0; for the Dividend consisting of Six Places of Decimals, and the Divisor only Three, I must take Three Places from the Quotient towards the Right-hand, to add to the Decimals of the Divisor, which makes them equal to those in the Dividend; so will the Work be as underneath expressed.

3.746) 172.500000 (46.049

The End of the First BOOK.

THE

THE
Art of Surveying,
The SECOND BOOK.
Containing the Eſſential Part of
GEOMETRY
In the Practice of
SURVEYING,
Divided into Four Parts, *Viz.*

I. The Firſt Part Contains the Deſcription and Inſcription of all *Geometrical Figures*.

II. The Second Part Contains the Menſuration of all *Superficial Figures*; Demonſtrated in Problems, Theorems, Definitions, and *Arithmetically* Solved.

III. The Third Part Contains the Dividing, or Cutting of Figures *Geometrical*, into Parts, Equal, or Unequal, as ſhall be required.

IV. The Fourth Part Teacheth how to Reduce one Figure into another, ſtill keeping the ſame Proportion; and to Add and Subſtract *Geometrically*, one Figure to, or from another, with their *Arithmetical* Solutions alſo to each Problem.

Comprized into a Plain and Practicable Method.

By *JOHN WING*, Math.

LONDON,
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THE ART OF SURVEYING.

BOOK II.

Consisting of Definitions, and Problems Geometrical.

PART I.

The DEFINITIONS.

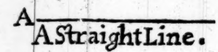
A POINT is that small part which cannot be divided, whose part is nothing, as A in the Margin.

A (.) A Point.

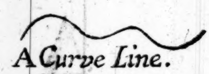
Euclid 2. 1.

A Line is a Length without Breadth or Thickness, of which there are two sorts, *viz.* Straight and Crooked, which kind of Magnitude is conceived in the Measuring of Roads, Inclosures, or the Distance of one Place from another.

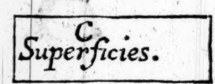
A Straight Line is the shortest Extension betwixt two Points, as the Line in the Margin A.



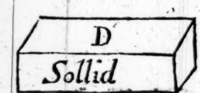
A Spherical, or Crooked Line, hath Compass, and so it differeth from a Right Line, and being Regular, is called, an Arch-Line; and Irregular, is called, a Curve Line, as in the Margin.



A Superficies hath only length and breadth, the Extreams whereof are Lines; and a Plain Superficies, is that which lieth equally betwixt his Lines, as the Figure C in the Margin.



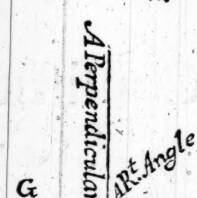
A Solid is that which hath Length, Breadth, and Thickness, represented by D in the Margin.



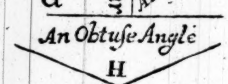
An Angle is the meeting together of two Lines in one Point, so meeting, that they make not one Straight Line; and if the Lines that contain the Angle, be Right Lines, then is that Angle said to be a Right Lined Angle, as E in the Margin; if Circular, as the Figure F; then is that said to be a Spherical Angle.

Of Angles, there are 3 sorts, *viz.* { 1. Orthogonal. 2. Obtuse, or Blunt. 3. Acute, or Sharp.

Of the First; when one Line falleth down plumb upon another, it maketh 2 Right Angles, each containing 90 Degrees, as the Figure G.

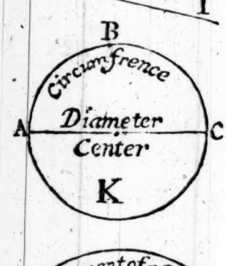


Of the Second; an Obtuse, or Blunt Angle, is wider than a Right Angle, therefore always more than 90 Degrees, as the Figure H.

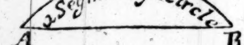


Of the Third; an Acute (or Sharp) Angle, is less than a Right, or Rectangle, therefore always lesser than 90 Degrees, as is demonstrated by the Letter I in the Margin.

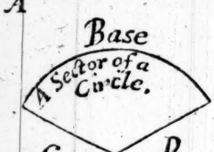
A Circle is a Plain Figure contained under one Crooked-Line, called, his Circumference; in the Middle whereof, is a Point called, his Center; from whence all Lines drawn to the Circumference, are of equal Length, and are called Semidiameters: See the Figure K, Semicircle A, B, C.



A Portion, or Segment of a Circle, is contain'd under a Chord-Line, and part of a Circumference, A B being the Chord-Line.

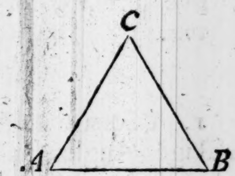


A Sector of a Circle is contain'd upon the Ends of 2 Right-Lines, or Semidiameters, making an Angle in the Center, having any part of the Circumference for its Base, as C D.

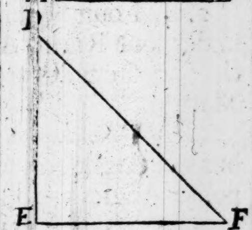


A Quadrant is the fourth part of a Circle, and is made by letting two Lines concur of equal length, and making a Right Angle, and from that Angle describing an Arch to touch the other end of each Line, represented by the Figure L in the Margin.

Right Lin'd Figures are contain'd under Right Lines, whereof three sided Figures, are such as are contain'd under three Lines, and are call'd Triangles; whereof, in respect of their Sides, there are three sorts, *viz. Equilateral*, *Isosceles*, *Scalenum.* And in respect of their Angles, there are also three sorts, *viz. Oxigonium*, *Orthogonium*, *Ambligonium.*



The Exposition in respect of their Sides, *viz.* { A Triangle of three equal Sides, is called *Equilateral*; two equal Sides is called *Isosceles*; and a Triangle with one Blunt Angle, is call'd, *Scalenum.*



The Exposition in respect of their Angles, *viz.* { A Triangle of three Sharp Angles, is called, *Oxigonium*; with one Right Angle, *Orthogonium*; with one Blunt Angle, *Ambligonium.*

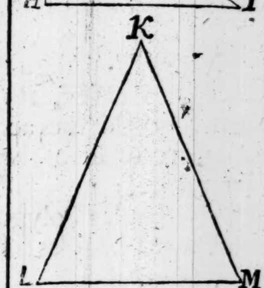
By which former Definition, it appeareth, That every Triangle hath a double Name; and so there are seven sorts of Plain Triangles.

1. An *Equilateral Oxigonium* Triangle, is contain'd under three equal Sides, and three Sharp Angles; as the Triangle A B C in the Margin.

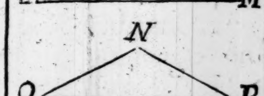
2. A Right Angled *Isosceles*, hath one Right Angle, and two equal Sides; as the Angle D E F.

3. A Right Angled *Scalenum*, hath one Right Angle; as the Angle G H I.

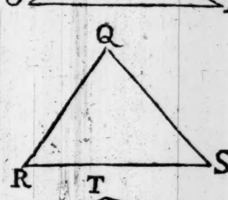
4. An *Oxigonium Isosceles*, hath three sharp Angles, and two equal Sides; as the Angles K L M.



5. An *Isosceles Ambligonium*, hath two Sides equal, and one Blunt Angle; as the Angle N O P.



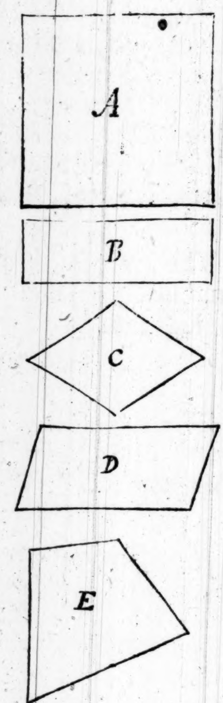
6. An *Oxigonium Scalenum*, hath three Sharp Angles, and three unequal Sides; as the Angle Q R S.



7. An *Ambligonium Scalenum*, hath one Obtuse, or Blunt Angle, and three unequal Sides; as the Angle T V W.

Four sided Figures are such as are contained under four Sides, or Lines, *viz.* under 4 Right Lines, whereof

There are five sorts, *viz.*
1. A *Square*.
2. A *Long Square*, or *Parallelogram*.
3. A *Rhombus*.
4. A *Rhomboides*.
5. A *Trapezium*.



1. A Square is contain'd under 4 equal Sides, and 4 Right Angles, as A.

2. A Long Square, or Parallelogram, is contain'd under four Right Angles, but not equal Sides; yet the opposite Sides are equal, as the Figure B in the Margin.

3. A *Rhombus* is contained under 4 equal Sides, but not Right Angles, as the Figure C, yet the opposite Angles are all equal.

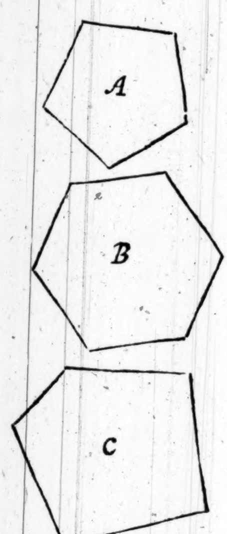
4. A *Rhomboides* is contain'd under 4 Lines, whose opposite Sides are equal, and opposite Angles equal; but yet not all equal Sides, nor any Right Angles, as the Figure D.

All other 4 sided Figures, and 4 Angles, which have neither equal Sides, nor equal Angles, are called *Trapeziums*, as the Figure E in the Margin.

Many sided Figures which consist of more than 4 Sides, are called, *Polygons*, and do every of them receive their Names according to the Number of their Angles; whereof there are two kinds, Regular and Irregular.

1. Regular Polygons, are such as have equal Sides, and equal Angles: Hence they are called, Regular Polygons.

2. Irregular, are such as have neither equal Sides, nor equal Angles; therefore called, Irregular Plots, or Polygons.



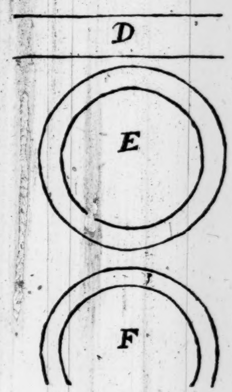
1. Of the First; A *Pentagon*, is a Polygon, contained under 5 equal Sides, and 5 equal Angles, as the Figure A.

An *Hexagon*, is a Figure, or Polygon, contained under 6 equal Sides, and 6 equal Angles, as the Figure B; and so of the rest, being denominated according to the Number of their Sides.

2. Of the Second kind of Polygons, called, Irregular Polygons, which have neither equal Sides, nor equal Angles, as the Figure C.

Paral-

Parallel-Lines, are Lines, or Lines drawn equidistant in all places one from another, of such there are two sorts, *viz.* The Right Lin'd Parallel, and the Circular.



1. Of the First; A Right Lin'd Parallel, is two Right Lines equi-distant in all places one from another, which being drawn to an infinite Length, would never meet, as the 2 Right Lines at D.

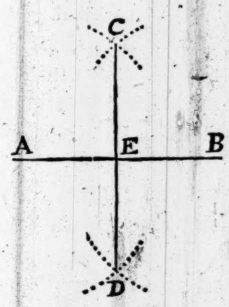
2. Of the Second; A Circular Parallel, is a Circle, or part of a Circle, drawn within or without another Circle upon the same Center, as E, and F.

PROBLEM I.

To Divide a Line given, not being Infinite, into two Equal Parts, at Right Angles.

THEOREM.

OPEN your Compasses to a greater Distance than ½ of the Line given; set one Foot in one end of the Line given, and with the other make an Arch above and below the Line given; then (the Compasses unaltered) set one Foot in the other end of the given Line, and cross the former Arches: Lastly, from those two Intersections, draw a Line, and it shall cut the Line given, into 2 Equal Parts at Right Angles.



EXAMPLE.

Let A B be a Line given, C, D the 2 Intersections found, by which the Line C D is drawn, which cutteth the Line A B, at E, into 2 equal parts, with Right Angles.

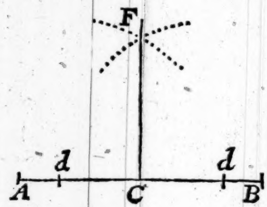
PROBLEM II.

From a Point in a Line given, to raise a Perpendicular.

THEOREM.

Set one Foot of the Compasses in the Point, and with the other make a Point on each side of the Point given in the Line, equidistant from the Point given; then open your Compasses to any wider Distance, and set one Foot of your Compasses in one of those made

Points, and with the other make an Arch above the Line given, (the Compaſſes unſtirred) ſet one Foot in the other made Point, and croſs that former Arch; from the Interſection of theſe two Arches to the Point given, draw a Line, which ſhall be the Perpendicular required.



EXAMPLE.

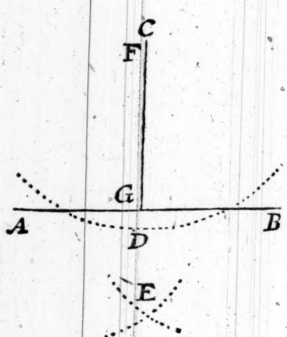
Let A B be the Line given, C the Point aſſigned, *d d* the two made Pricks, or Points, equidiſtant from C, F, the Point, or Interſection above, by which the Perpendicular F and C is drawn.

PROBLEM III.

From a Point above, to let fall a Perpendicular on a Ground-Line.

THEOREM.

Set one Foot of the Compaſſes in the Point aſſigned, and with the other make an Arch below the Line given, ſo that it may touch the Line in two places; then ſet one Foot of the Compaſſes in one of thoſe Points, where the Arch cutteth the Ground Line, and with the other make a Portion of an Arch below the Line given; then (the Compaſſes unſtir'd) ſet one Foot in the other Point, and croſs that Arch: Laſtly, lay your Ruler by the Point found, and the other Point aſſigned, and ſo draw the Perpendicular to the Line given.



EXAMPLE.

Let A B be the Line given, C the Point aſſigned, and D the Arch Line drawn, E the Point found, by which the Perpendicular F G is drawn.

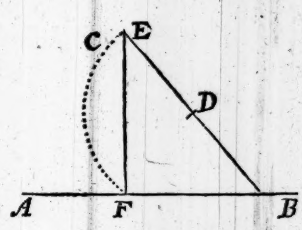
PROBLEM IV.

From a Point above to draw a Perpendicular, when there wanteth ſpace below the Line.

THEOREM.

From the Point aſſigned, to any part of the Line given, draw a Slope-Line, which Divide into two equal parts; then ſet one Foot of

of the Compasses in that Point, opening the other to that half, letting one Foot stand open in that Point where the first half is found to be, and with the other strike an Arch from the Point assigned to the Ground Line, and the Intersection in the Ground Line, shall be the Perpendicular Point to the Point assigned.



EXAMPLE.

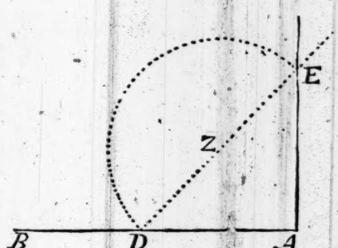
Let A B be the Line given, E the Point assigned, B C a Line drawn, D one half thereof, E F the Arch drawn; so is F the Point of the Perpendicular found to E: Lastly is the Line E F, the Perpendicular required.

PROBLEM V.

Upon the End of a Line given, to raise a Perpendicular.

EXAMPLE.

Let A B be the Line given, and let A, the end thereof, be the Point assigned; whereon to raise a Perpendicular Line, open the Compasses to any convenient Distance, and set one Foot in the Lines-end at A, and make a Point with the other above, as at Z; (the Compasses unstir'd) describe the Portion of the Circle D E, which cutteth the Ground Line in D, and the Point made above the Line at Z, and it will cut the Arch Line in E: Lastly, draw the Line A E the Perpendicular required.



PROBLEM VI.

To raise a Perpendicular upon the End of a Line given, another Way.

EXAMPLE.

With your Compasses opened to any convenient Distance, prick off 5 small and equal Divisions from A towards B, upon that same Line A B; then take with your Compasses, the Distance from A, to 4 Divisions; and setting one Foot in A, describe with the other the Arch F G; then take the Distance

K 2 from

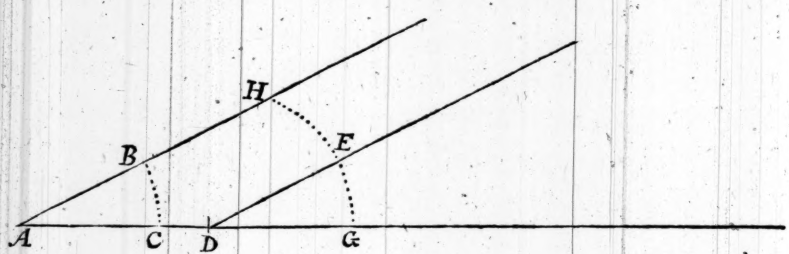
from A, to 5 Divisions, and placing one Foot of the Compasses in 3, with the other Foot, describe the Arch H O, intersecting the former in the Point P: Lastly, from P, draw the Line A P, which is the Perpendicular to the given Line A B required.

PROBLEM VII.

An Angle being given, and a Point also given in one Side thereof, to draw a Line Parallel to the other by that Side assigned.

EXAMPLE.

From the Point assigned, make an Angle equal to the Angle given, by the Direction of the next Problem, so shall the Side produced, be Parallel to that Side of the Angle it cutteth not. As



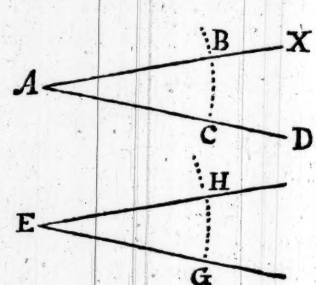
admit A B C be the Angle given, D the Point assigned, D E G the Angle made equal to A B C; so is the Line D E, found to be Parallel to A B.

PROBLEM VIII.

To make one Angle equal to another Angle given.

EXAMPLE.

Let the Angle given be X A D, and it is required to make another Angle equal to the same: Open the Compasses to any convenient Distance, and setting one in A the given Angle, with the other describe the Arch B C; then with the same Extension set one Foot in E the Line assigned, and with the other describe the Arch H G; which done, take the Extent of the Arch Line B C, and setting one Foot of the Compasses in G, with the other mark the Point H: Lastly, with your Ruler draw the Line E H, which shall make the Angle H E G, equal to B A C required.



PRO-

PROBLEM IX.

Unto a Line given, to draw a Line Parallel to it, at any Diſtance given.

EXAMPLE.

Let the Right Line given be A B, unto which it is required to draw another Parallel Line: Firſt open your Compaſſes to the Diſtance given, and ſetting one Foot in the Point A, with the other make an Arch on that ſide the Line whereon the Parallel Line is to be; then make the like Arch at the other end of the Line at B, as the Arch Lines C and D: Laſtly, lay your Ruler by the Convexity, or outſide of thoſe two Arches, and draw the Line C D, which ſhall be Parallel to the given Line A B, as was required.

PROBLEM X.

To draw a Parallel Line, without ſtirring the Compaſſes from the Diſtance given, a more Readier and Exacter Way.

EXAMPLE.

Let A B be the Line given, to which I would make another Parallel: I open my Compaſſes to the Diſtance required, and deſcribe the Arch E D F, then the Foot remaining in F, deſcribe the other Arch A D G; then remove the Compaſſes to B, and do the like; then lay the Ruler that it may cut both the Interſections; then draw a Line from the Point of Interſection in the one end, till it touch the Point of Interſection in the other end, and ſo is E D C Parallel to A B, which was required.

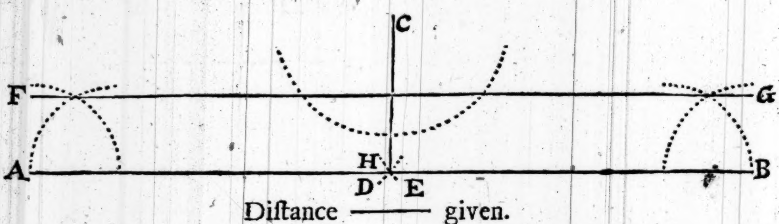
L PRO-

PROBLEM XI.

From a Point assigned unto a Line given to draw a Perpendicular, without stirring the Compasses from the Distance given.

EXAMPLE.

Admit A B be the Line given, C, the Point assigned, and the Line D E, the Distance of the Compasses: First, draw the Parallel



Line F G, and A B, at that Distance; then by the *Third Problem*, let fall the Perpendicular C H, which is the thing required.

PROBLEM XII.

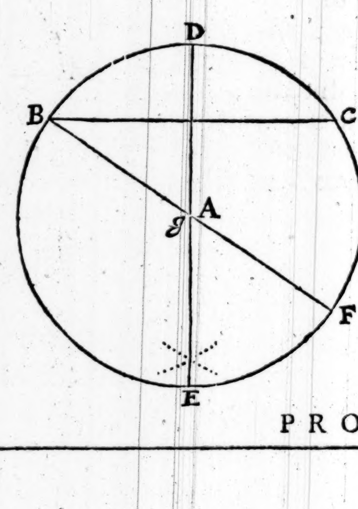
A Circle being given, to find the Center thereof.

THEOREM.

From any part of a Circumference given to another, draw a Chord-Line, which divide into two equal parts, at Right Angles, by the *First Problem*, letting that Line end in the Circumference of the Circle; so shall that Line be the Diameter of the Circle, and the Middle the Center.

EXAMPLE.

Admit A to be the Circle given, whose Center is required; let B C be the Chord-Line drawn, which is Divided into two equal parts at Right Angles, by the Diameter D E in the one half, is the Center, which may be found by setting the Distance of C D, from E to F, the Line B F drawn, cutteth the Line D in *g*, which Point (*g*) is the Center to the Circle A, which was required.



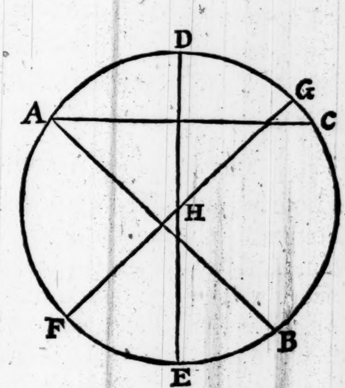
PRO-

PROBLEM XIII.

To bring three Pricks (not lying in a Straight Line) into a Circle.

Theorem.

Firſt draw three Points given, into an Angle, and divide each Side into 2 equal parts, at Right Angles; and where the 2 Perpendiculars cut one another, that Point ſhall be the Center required.



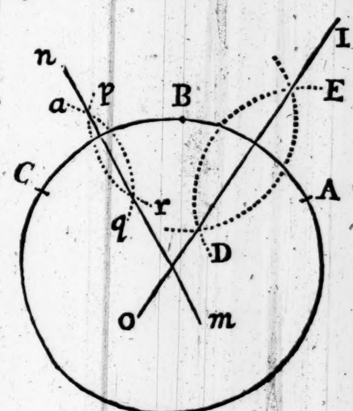
EXAMPLE.

Admit A B C, the three Points given; let the Line A B, and A C, be drawn; let A C be divided at Right Angles by F G; now D E, and F G, cut one another in H; which is the Center found, as was required.

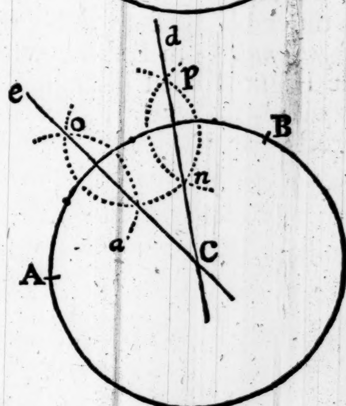
PROBLEM. XIV.

To perform the former Work a nearer Way, and to find the Center to any Arch, or Portion of a Circle.

EXAMPLE.



Let A, B, and C, be the three Pricks to be brought into the Edge of a Circle, by finding a Center common to them all: Firſt, open the Compaſſes to ſomething more than half the Diſtance between two of the Pricks, (as are A B;) then ſet one Foot in A, and deſcribe the Arch D E; likewiſe ſet one Foot in the Prick at B, croſſing the former Arch D E: Then from theſe two Interſections, draw the Line O I; then taking ſomething more of the Diſtance between the 2 Pricks C and B; make the 2 Arches *a q*, and *r p*, and from their Interſection draw the Line *n m*; and where theſe two Lines cut one another is the Center, that runneth upon the 3 given Pricks.



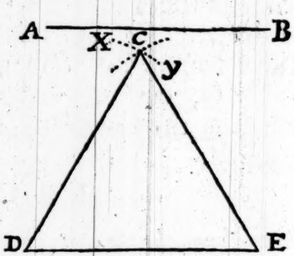
In like manner you may find the Center to any Arch, or Segment of a Circle, as may be seen in the Margin, marked with A B C, and *a o d p n*; otherways, *vide* Path-way to Knowledge, the 26th Conclusion.

PROBLEM XV.

To make an Equi-angled Triangle, whose Sides are equal to a Line given.

EXAMPLE.

Let A B be a Line given, to make an Equi-angled Triangle, whose Sides shall be equal to the given Line A B; then open the Compasses the length of the Line given, and lay down the same in that place, where you would have the Triangle described, *viz.* D E; afterwards set one Foot of the Compasses in D, and with the same Extent make the Arch X Y; then set one Foot of the Compasses in the other end of the Line, and cross the former Arch in C; then from C, to D and E, draw the Equi-angled, or Equilateral Triangle C D E, as was required.

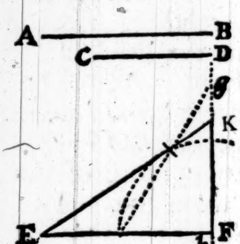


PROBLEM XVI.

To make a Right Angled Triangle, the two Sides being given.

EXAMPLE.

Let A B, and C D, be the two Lines given: First, lay down the Line A B, for the Base E F; then, by the *Fifth Problem*, raise the Perpendicular *(g h)*; then take the Length of the other given Line C D, and set it upon the end of the Base, at F; then draw the *Hypothenuse* from E to K, which includeth the Right Angled Triangle E K F, as was required, and as the Figure in the Margin directs.



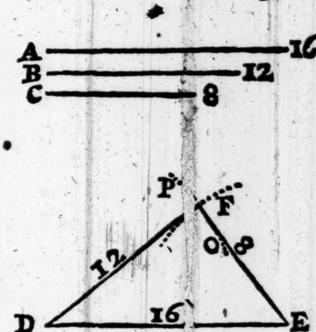
PRO-

PROBLEM XVII.

Three Lines of Unequal Lengths given to make a Triangle, if the Sum of the two shortest Sides be longer than the third.

EXAMPLE.

Let the three Lines given, be A, B, C, whereof a Triangle is to be made: First, place the longest Line A, from D, to E, for the Base; then take the Length of the second Line B, and set one Foot in the end of the Base at D, and make the Arch P O; then open your Compasses to the Length of the third Line C, and set one Foot in the other end of the Base at E, and cross the former Arch at F; from which Intersection draw the Lines F D, and F E, whose Sides are equal to the three Sides, or Lines given, A, B, and C.

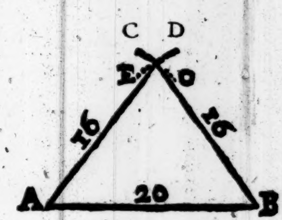


PROBLEM XVIII.

To make an Isosceles *Triangle, upon a Right Line given.*

EXAMPLE.

Let the Right Line given, be A B, 20; whereon it is required to describe an *Isosceles* Triangle, whose Sides shall be 16 a piece; open the Compasses upon the Scale to 16; and with one Foot in A, describe the Arch C O; and with the same Distance, place one Foot in B, and cross the former Arch as E D; and to that Intersection draw two Lines from A and B; which shall include the Triangle required.



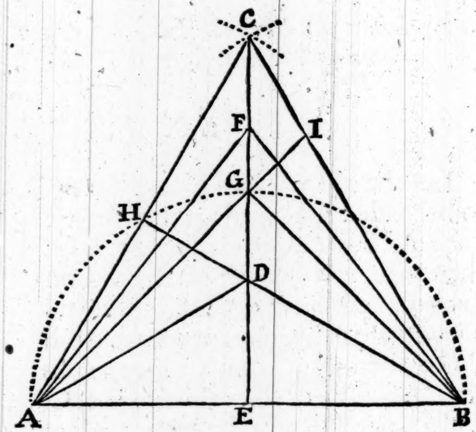
PROBLEM XIX.

A Triangle being made, to find of what kind it is.

THEOREM.

Upon the Base Line of the Triangle, describe a Semicircle; and upon the Center thereof, raise a Perpendicular, in height equal, or higher than the third Angle; then if the Angle fall within the

Circumference, that Triangle is *Ambligonium*; and if it fall upon the Circumference, it is *Orthogonium*; but if the third Angle fall without the Circumference, then is that Triangle *Oxigonium*; and if the third Angle fall upon the Perpendicular, it is either Equilateral, or *Isosceles*: It is Equilateral, when all the three Sides are equal, otherways it is *Isosceles*; but if the Angle do not fall upon the Perpendicular, then it is *Scalenum*.



EXAMPLE.

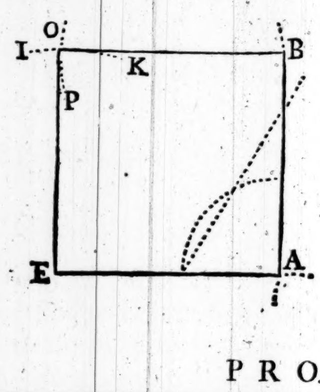
Admit A B C, be the Triangle; A G B half of the Circumference drawn upon the Center E; and E F, a Perpendicular, raised upon the Center E; now for that the Angle C falleth without the Circumference, therefore the Triangle A B C, is *Oxigonium Equilateral*; for that the Angle C, falleth upon the Perpendicular, therefore the Triangle A B G, is a Right Angled *Isosceles*; the Triangle A B H, is a Right Angled *Scalenum*; A B F, an *Oxigonium Isosceles*; A B D, an *Ambligonium Isosceles*; A B I, is a *Scalenum*.

PROBLEM XX.

To make a Square, whose Sides shall be equal to a Line given.

EXAMPLE.

Admit A E, be the Line given: First, make the pricked Right Angle by the *Fifth Problem*; then set the Side of the Square, on each side thereof, from the Angle at A; then set one Foot in E, and describe the Arch I K; and with the same Distance, set one Foot in B, and describe the Arch O P; and from that Intersection draw the Lines O E, and I B; so is the Square I B A E made, whose Sides are equal in Length to the Line A E, required.



PROBLEM XXI.

To make a Long Square, or Parallelogram, equal to two given Lines.

EXAMPLE.

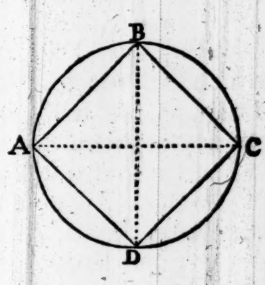
Admit A B, and C D, to be the two Lines given: First, by the *Fifth Problem*, make the prick't Right Angle O L P; then set A B, for the Base from P to L; next let the Line C D, be set from L to O; then take with your Compasses, the Length of the Line C D, and set one Foot in P, and describe the Arch *(eq)*; then take the Length of the Line A B, and set one Foot in O, and cross the former Arch; and from that Intersection, draw the Lines I P, and I O; which include the Long Square I O L P.

PROBLEM XXII.

To make a Square Quadrat in a Circle assigned.

EXAMPLE.

First, draw the Circle, and cross it with two Diameters, A C, and B D, represented by the two pricked Lines; then make, or draw the other four Lines; as from A, to B; from B, to C; from C, to D; and from D, to A; which shall include a Square Quadrat in the Circle assigned: And this is also termed, The Inscribing of a Square within a Circle.

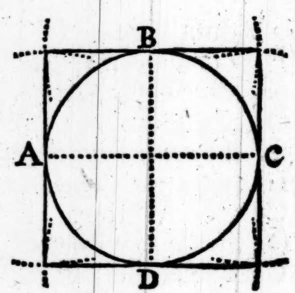


PROBLEM XXIII.

To make a Square Quadrat about a Circle aſſigned.

EXAMPLE.

Firſt, draw two Diameters a-croſs-ways, ſo that they make four Right Angles in the Center; then with your Compaſſes take the Length of the half Diameter, and ſet one Foot of the Compaſſes in each end of thoſe Diameters, as at A,B,C,D; drawing the Arch-Lines in every Corner, and croſs each of 'em from the Diameters with the ſame Diſtance; then from each Interſection, draw 4 Right Lines, which ſhall include the Square Quadrat about the Circle aſſigned.



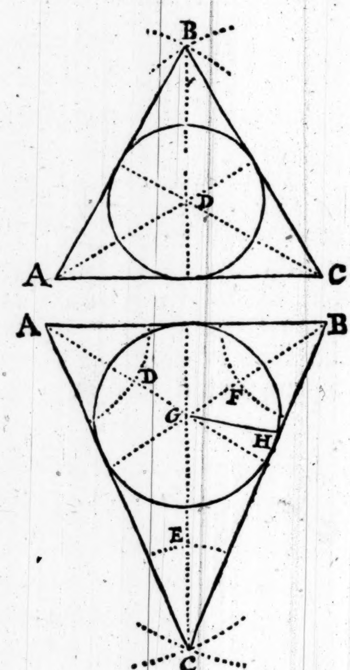
PROBLEM XXIV.

To draw a Circle within a Triangle appointed.

EXAMPLE I.

If the Triangle have all Sides equal, then take the Middle of every Side, and from the contrary Corner draw a Right Line unto that Point; and where thoſe Lines do croſs each other, there is the Center; in which ſet one Foot of the Compaſſes, and ſtretch out the other to the Middle Prick of any of thoſe Sides, and ſo draw a Circle which ſhall touch every ſide of the Triangle, but ſhall not paſs without any of them.

But to do this in all other kinds of Triangles, you muſt divide every Angle in the Middle, and ſo draw Lines from each Angle to their Middle Prick; and where thoſe Lines do interſect one another, there is the Common Center.



EXAMPLE II.

Admit this Triangle ABC, which by the *Eighth Problem*, I divide

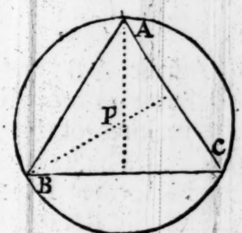
vide into two equal parts at D E F; from whence are drawn the Prickt Lines of Division, A D, B F, and C E, which cross in G; therefore shall G, be the Common Center; then make one Perpendicular, *viz.* G H, and set one Foot of the Compasses in G, and extend the other to H, and so draw the Circle, which will justly answer to that Triangle.

PROBLEM XXV.

To draw a Circle about any Triangle assigned.

EXAMPLE.

First, Divide two Sides of the Triangle into equal parts, *viz.* in the half; and from those two Pricks, raise two Perpendiculars; and where they two cut one the other, there is the Center, upon which you may draw the Circle, which shall include the Triangle as was required.



This also may be performed by the *Fourteenth Problem.*

PROBLEM XXVI.

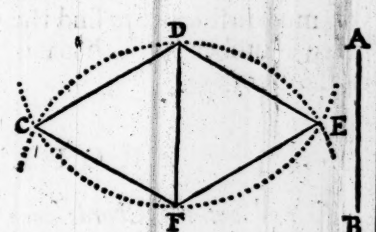
To make a Rhombus, *whose Sides shall be equal to a Line given.*

THEOREM.

A *Rhombus* may be described by the *Fifteenth Problem*, by joyning two Equi-angled Triangles together, leaving out the Pricked Line in the Figure.

EXAMPLE.

Admit A B, to be the Line given; then by working, as the Figure in the Margin directs, or according to the *Fifteenth Problem*, either way will make the *Rhombus* C D E F, whose Sides are equal to the Line A B, as was required.



PROBLEM XXVII.

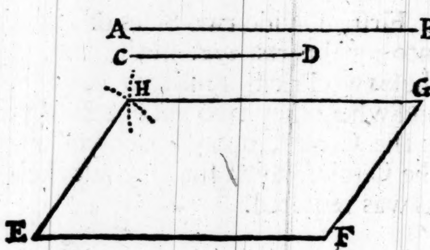
To make a Rhomboides, *the two Sides being limited.*

THEOREM.

First, lay down the longer of the two Sides given; then open your Compasses to the Length of the shorter Line, and draw another Line Parallel to that, and of the same Length; then by the end of those two Lines is included the *Rhomboides*.

EXAMPLE.

Admit AB, and CD, be the two Lines given for the making of the *Rhomboides*; which, according to the former Directions, makes the *Rhomboides*.



Of POLYGONS.

The making of Equi-angled, or Regular Polygons.

TO make any Regular, or Equi-angled Polygons; you must first make a Blind, or White Circle; and then find out the Chord thereof according to the Side of the Polygon; which Chord-Line, or Distance, must be set so many times in the Circumference of that Circle; and Lines being drawn from Point to Point, will include the Polygon; therefore before you can make a Polygon, you must first learn to find the Chords in a Circle, according to a given Number; which is taught as followeth, from the *Trigone*, to the *Decagone*.

PROBLEM XXVIII.

To find out the Chords in a Circle from the Trigone, *to the* Decagone.

THEOREM.

Which are performed, as in the Exposition of the Demonstration following.

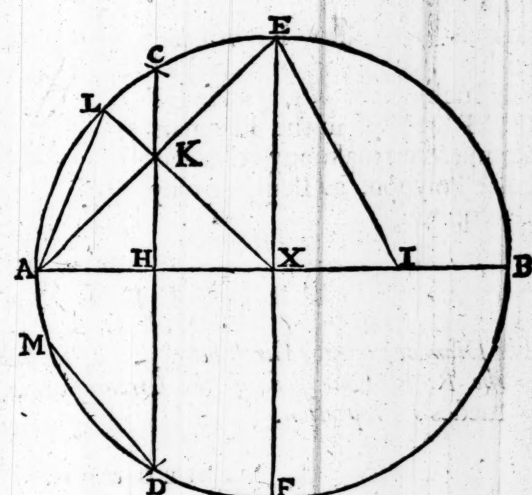
EXAM-

EXAMPLE.

Admit A B E F, be the Circle given to find the Chords thereof.

First, draw the Diameter A B; then open your Compasses to the Semidiameter; set one Foot in A, and with the other Foot cross the Circumference at C, and D, and draw the Line C D, which will be the third Chord.

DEMONSTRATION.



4. This done, draw the Line E F, which divideth the Diameter A B, into two equal parts at Right Angles; then draw the Line A E, which shall be the fourth Chord-Line, or the Side of an inscribed Square.

5. To find the Fifth, set one Foot of your Compasses in H, and extend the other to E; and with that Distance, cross the Diameter in I, and draw the Line E I, which shall be the Fifth Chord, or the Side of a *Pentagon*.

6. The Sixth is the Semidiameter, which is the Side of a *Hexagon*.

7. The Seventh is half the Third, as C H, or H D; which is the Side of an Inscribed *Heptagon*.

8. To find the Eighth, lay your Ruler upon the Center X, and the Intersection K, which will cut the *Periphery* in L; then draw the Line A L, which is the Side of an Inscribed *Octagon*.

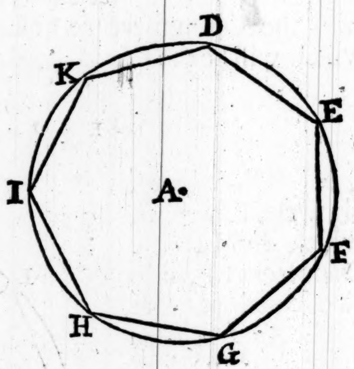
9. The Ninth is a third part of the Arch C A D, as M D.

10. The Tenth is the Line X I, which is the Side of an Inscribed *Decagon*.

PROBLEM XXIX.

To make a Heptagon, *the Circle Inscribing it being given.*

EXAMPLE.

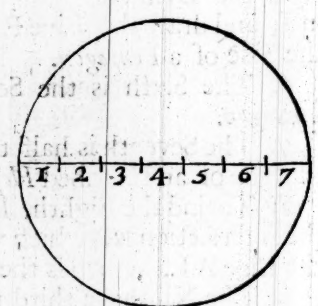


Let A, be a Circle given, wherein a *Heptagon* is to be Inscribed; therefore by the last *Problem* find out the Seventh Chord G H, or H I, and place it Seven times in the Circumference; then from Point to Point, draw Right Lines within the given Circle, which will Include the *Heptagon* D E F G H I K; and in the like manner may you make any other Regular Polygon, as shall, or may be required.

PROBLEM XXX.

The Diameter of any Circle being given, to find a Right Line equal to the Right Extension of the Circumference, according to Archimedes's *Proportion.*

THEOREM.



True it is, there is no Agreement betwixt Circular and Right Lines, to a precise Quantity, as yet known; the Old-retained Proportion 7 to 22, is precise enough, and sufficiently near enough the Truth, for any Business.

Now the Diameter being given to find the Circumference, take $\frac{1}{7}$ of the Diameter, and add it to three Diameters, so have you its Circumference in a Straight Line.

EXAMPLE.

1. Diameter. 2. Diameter. 3. Diameter.

PRO-

PROBLEM XXXI.

The Length of the Diameter being given in Numeral Denomination, to find the Circumference Arithmetically.

Rule.

Multiply the Diameter by $3\frac{1}{7}$, so have you the Circumference.

EXAMPLE.

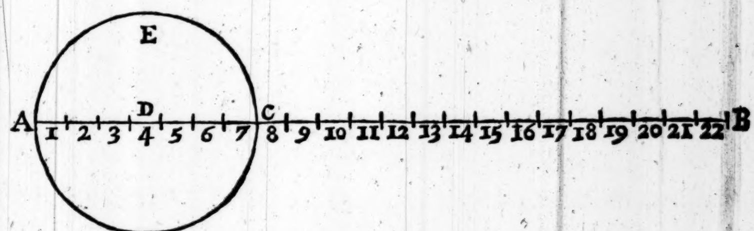
Admit the Diameter to be 21; which Multiplied by $3\frac{1}{7}$, produceth 66, for the Circumference.

PROBLEM XXXII.

A Right Line being limited, to make a Circle, whose Circumference being extended, shall be equal thereunto.

Theorem.

Of the Line given, take $\frac{7}{22}$, which part divide into two equal halfs, and with that Distance make a Circle; and the Circumference thereof being extended, shall be equal to the Line given.



EXAMPLE.

Admit A B, be the Line limited; then let A C be found $\frac{7}{22}$, and let the Middle part thereof, be found at D; upon which Point describe the Circle E; the Extension of the Circumference thereof is equal to the Line A B, which was required.

PROBLEM XXXIII.

The Extension of a Circumference being given in Numeral Denomination, to find the Length of a Diameter Arithmetically.

Rule.

Multiply the Circumference given, by 7, and Divide that Product by 22; so have you the Length of the Diameter required.

EXAMPLE.

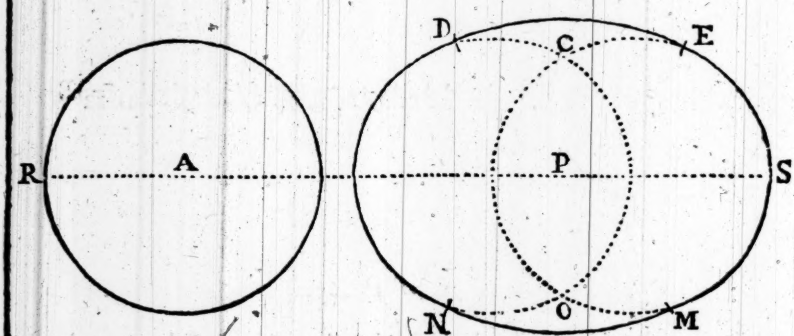
Admit the Circumference given, be *66*; which Multiplied by 7, produceth 462; which Divide by 22, quotes 21, for the Diameter.

PROBLEM XXXIV.

To describe a Geometrical Oval *at any Circumference appointed.*

EXAMPLE.

Let A be the Circumference appointed to describe an Oval of: First, draw a Blind, or White Line, as R S; upon which describe a White, or Blind Circle, equal to that of A; then set one Foot in the Edge of the Circle in the Right Line, and draw ano-



ther of the same Circumference; then open the Compasses to the Length of your Diameter, and set one Foot in O, and strike the Arch D E; with the same Distance set one Foot in C, and strike the Arch M N, which includeth the Oval P.

PRO-

PROBLEM XXXV.

An Angle being given, to find the Quantity thereof.

EXAMPLE.

Suppose KIL were an Angle given, and that it were required to find the Quantity thereof: Open your Compasses from the beginning of a Line of Chords to 60 Degrees; then with that Extension place one Foot in I, and with the other describe the Arch C B; then take in your Compasses the Distance of C B, and applying that Distance to the Scale of Chords, which reacheth from the Beginning, to 27 Degrees, which is the Quantity of the Angle required.

Note. If any Angle given, shall contain above 90 Degrees, you must then protract it at twice, by taking first the whole Line, and then the Remainder, or dividing the Angle into any two parts equal unto it.

As if the Angle were 159 Degrees; take 80, and 79; or 90, and 69 Degrees, *&c.*

PROBLEM XXXVI.

A Portion, or Part of a Circumference being given to find the right Extension thereof.

EXAMPLE.

First, find out the Center to that Arch by the *Fourteenth Problem*, by which Point draw a Line by each end of the Arch, which will make an Angle, the Quantity whereof, find by the last Problem; and consequently the Circumference of the whole Circle, whereof that is a part; then say, (by the *Rule of Three*) as the Degrees of that Angle are in proportion to 360, so is that Arch to the whole Circumference.

The End of the First Part.

GEOMETRY.

PART II.

Definitions, and the Measuring of Geometrical *Figures.*

TO Measure the Superficies of any Figure, is to shew how many Squares are therein contained, according to a Scale assigned.

A Scale is any Right Line divided into any equal parts, by which equal parts may be represented; an Inch, a Foot, a Yard, a Pace, a Perch or Pole, a Mile, a League, a Degree, *&c.* according to the thing to be represented.

Now, notwithstanding that a Triangle is one of the Simplest Figures of all Superficies, yet for as much as the Ground and Measuring of a Triangle, and all other Figures, is Demonstrated out of the Square, and Long Square, I shall therefore begin with these two Figures.

PROBLEM I.

To Measure a Geometrical, *or True Square.*

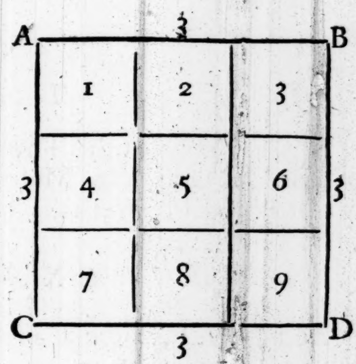
THEOREM.

EVery Square is a Rectangled Equilateral Parallelogram, whose Sides are all equal: Hence in all Right Angled Parallelograms, the Length Multiplied by the Breadth produceth the Area thereof.

EXAM-

EXAMPLE.

Admit ABCD, whose Sides are brought into a true Square of 3, which Multiplied by 3, being both the Length and Breadth, produceth 9 for the Area; as may be seen by the Demonstration here in the Margin.



☞ *Note*, That the Square Root of the Area of any Square, is the Side thereof; as in this Figure, the Area is 9, whose Square Root is 3, which is the Side thereof required.

PROBLEM II.

The Side of a Square being given, to find the Length of the Diagonal, and true Area of a Square.

THEOREM.

The Diagonal is double in Power to the Side of the Square.

DEFINITION.

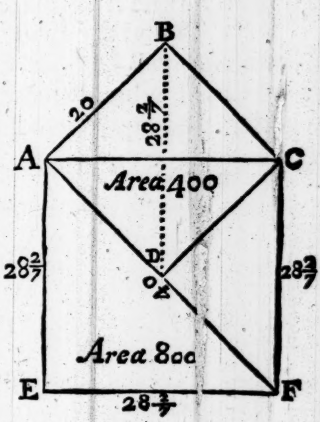
By the Power of a Line, is meant the Superficies made into a Square of the said Line.

RULE *Arithmetically.*

Therefore Multiply the Side into it self, and double the Product; from which Product Extract the Square Root by *Chap.* 8. *Book* I. which sheweth the Length of the Diagonal *Arithmetically.*

EXAMPLE.

Admit ABCD to be the Square made, whose Diagonal is BD; then make another Square, whose Side let be equal to AC, as the Square ACEF is: Now it is plain, that ACD is the $\frac{1}{2}$ of the Square ABCD, and that ACD is but $\frac{1}{4}$ part of the Square ACEF; therefore the Square ACEF, is double in Area to the Square ABCD.



For the Side of the Square ABCD, being 20; which Multiplied into it

ſelf, produceth 400; the which being doubled, maketh 800 for the Area of the Square ACEF, whoſe Square Root is $28\frac{2}{7}$ for the Diagonal B D.

For Meaſuring a Right Angled Triangle.

THEOREM.

By the Ground of this Theorem, a Right Angled Triangle may be thus Meaſured, *viz.* Multiply the Diagonal in it ſelf, and half of that Product ſheweth the Area.

EXAMPLE.

Admit AEF, to be a Triangle, whoſe Diagonal AF is 40; which Multiplied by 40, produceth 1600; whoſe half is 800 for the Area.

☞ *Note*, That if the Side of the Square be Rational; then is the Diagonal Irrational; but if the Diagonal be Rational, then is the Side Irrational.

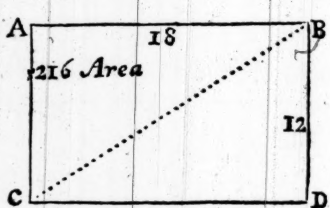
PROBLEM III.

To Meaſure a Long Square, or Parallelogram.

THEOREM.

Multiply the Length by the Breadth, the Product is the Area.

EXAMPLE.



Admit A B C D, to be an Oblong to be Meaſured, whoſe Length is 18, and the Breadth 12; which being Multiplied together, produceth 216 for the Area thereof.

To find the Length of the Diagonal Line B C; Square A B 18, and AC 12, which Squares added together, the Square Root thereof will be the thing required.

PROBLEM IV.

To Meaſure a Rhombus.

THEOREM.

Every *Rhombus* is an Oblique-angled Parallelogram Equilater, and is equal to that Long Square, whoſe Length is equal to one of the

the Sides, and Breadth is equal to the Parallel Distance thereof, and may be Measured several ways; but the most Common way is this that follows.

To find the Perpendicular.

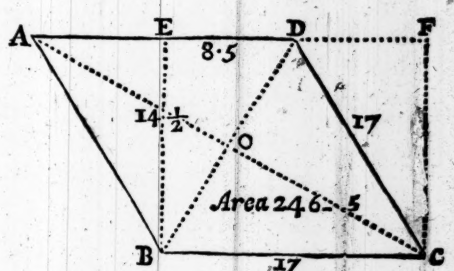
But first to find the Perpendicular E B or F C; Square A E and A B, and Substract the lesser Square from the greater; the Square Root of the Remainder is the Length of the Perpendicular required.

RULE.

Multiply the Length of the Perpendicular by one of the Sides, the Product is the Area.

EXAMPLE.

Admit A B C D, to be the *Rhombus* whose Side is 17, and the Perpendicular $14\frac{1}{2}$; which Multiplied together produceth $246\frac{1}{2}$, for the Area thereof, and is thus further Demonstrated, *viz.*



DEMONSTRATION.

Make a Long Square, whose Length let be equal to the Side of the *Rhombus*, and the Breadth equal to the Perpendicular, as the Long Square E B C F; now the Triangle A B E, is equal to the Triangle C D F, so consequently E B C F is equal to the *Rhombus* A B C D.

Note also *Arithmetically*, A Mean Proportion between E B, the Perpendicular, and B C the Side, is the Side of the Square equal to the *Rhombus*, or *Rhomboides*.

PROBLEM V.

Given A B *the Side of a* Rhombus *and one Diagonal, to find the other.*

THEOREM.

Divide the Diagonal A C, and B D, into two equal parts, making Right Angles at the Center O; then from the Square of A B, Subduct the Square of half the given Diagonal, the Square Root of the Remainder is half the other Diagonal.

PROBLEM VI.

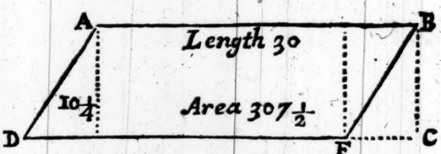
To Measure a Rhomboides.

THEOREM.

Every *Rhomboides* is equal to that Long Square, whose Length is equal to one of the Longest Sides, and the Breadth equal to the Parallel Distance.

EXAMPLE.

Admit A B F D to be a *Rhomboides*, whose Length is 30; the Perpendicular, or Parallel-Distance $10\frac{1}{4}$, which Multiplied together, produceth $307\frac{1}{2}$, for the Area thereof, as was required.



Note, Otherways it may be reduced into 2 Triangles by a Diagonal Line; which Multiplied by the Perpendicular, produceth the Area also.

PROBLEM VII.

To Measure Right Angled Triangles.

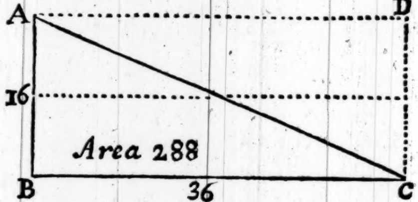
THEOREM.

Every Right Angled Triangle is half that Long Square, whose Length and Breadth are equal to the two containing Sides thereof.

Therefore Multiply the two containing Sides together, (*viz.* the Perpendicular and the Base) half the Product is the Area; or the Base by half the Perpendicular, or the Perpendicular by half the Base; either Product is the Area.

EXAMPLE.

Admit A B C to be a Right Angled Triangle to be Measured, whose Base B C is 36, and A B the Perpendicular 16, which Multiplied together, whose half Product 288 is the Area.



Otherwise 8 the half-Perpendicular, Multiplied by 36 the whole Base, the Product is 288 for the Area.

Or

Or 18, half the Base, being Multiplied by the whole Perpendicular 16, makes likewise 288 for the Area, as before.

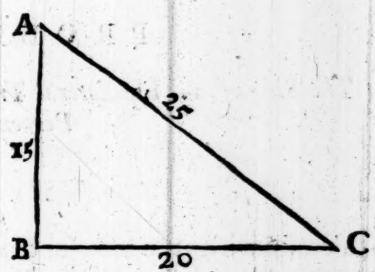
PROBLEM VIII.

Having given in a Right Angled Triangle, the Perpendicular and Base; to find the Length of the Hypothenuse, *&c.*

THEOREM.

The Line that Subtendeth the Right Angle, *viz.* the *Hypothenuse*, is double (or equal) in power, to both the containing Sides thereof; *viz.* The *Base*, and the Perpendicular.

EXAMPLE.



Admit A B C, to be a Right Angled Triangle, whose Subtendent, or *Hypothenuse* A C, is required; now the *Base*, or Side B C is 20, and the Perpendicular, or Side A B, is 15: Therefore to find A C, Square A B, and B C, severally; and the Square Root of their Aggregate, is the Length of the Subtendent A C, which is found 25.

To find either of the other Sides.

Admit the Subtendent Line A C, to be given 25, and the *Base* B C 20: Hence by the aforegoing Directions, Square the two Sides severally, and substract the lesser from the greater, and the Square Root of the Remainder is 15 for the Length of the Perpendicular Line A B, as was required: Observe the same Method in finding the Length of the *Base* Line B C.

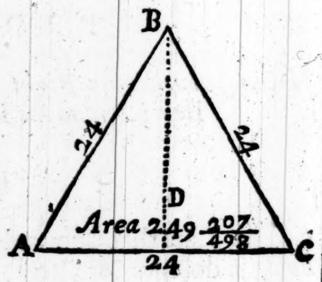
PROBLEM IX.

How to Measure an Equiangled Triangle.

THEOREM.

Cube half one of the Sides, and Multiply that Number by half the Perimeter; of that Product, Extract the Square Root, which sheweth the Area of the Triangle.

EXAMPLE.



Admit A B C, to be an Equilateral Triangle to be Measured, whose Side is 24, whose half is 12, the Cube thereof is 1728; which Multiplied by 36, half the Perimeter, the Product is 62208; whose Square Root is $249\frac{207}{498}$, near Rational, for the Area.

Otherways, it may be Measured by letting fall a Perpendicular from either Angle, to the opposite Side; and then Multiplying the half of the one, by the whole of the other, the Product is the Area.

PROBLEM X.

The Side of an Equilateral Triangle being given, to find the Perpendicular.

THEOREM.

Forasmuch as the Side subtending the Right Angle, is equal in power to both the containing Sides thereof; Substract the Square of half the Side, from the Square of the whole, and the Square Root of that Remainder is the Length of the Perpendicular.

EXAMPLE.

Admit the former Figure A B C, to be an Equilateral Triangle, whose Perpendicular is required; the Side of the Triangle is 24, whose Square is 576; and the half of 24 is 12, whose Square 144; which substracted from 576, there remains 432; whose Square Root is 20.79, for the Length of B D, the Perpendicular required.

PROBLEM XI.

An Isosceles *Triangle being given to find the Length of the Perpendicular, and also its Area.*

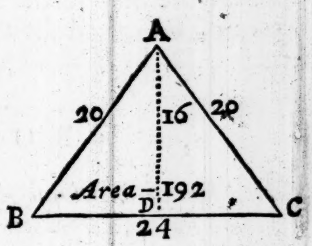
THEOREM.

By the Ground of the last Problem, substract the Square of half the unequal Side, from the Square of one of the equal Sides; the Square Root of the Remainder, is the Length of the Perpendicular.

EXAM-

EXAMPLE.

Admit one of the equal Sides, as A B, or A C, is 20, its Square 400; the half of the Unequal Side B C, is 12, and its Square 144; which substracted from the Square of A B 400, leaveth 256; whose Square Root is 16, the Length of A D, the Perpendicular required.



For the Area.

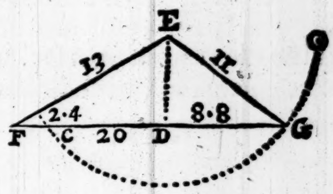
Multiply the Root 16, by ½ B C 12, it produceth 192, for the true Area: Or, Multiply ½ the Root 8, by B C 24, and it produceth 192, as before.

PROBLEM XII.

Three Sides of any Oblique Angled Triangle being given, to find where the Perpendicular shall fall.

THEOREM.

The greatest Side being put for the *Base*, upon which the Perpendicular shall fall, find both the Sum and Difference of the other two Sides, and then the Proportion will be as followeth. As the *Base*, or greater Side, is to the Sum of the other two Sides, so is the Difference of the same Sides to a fourth Number, which being substracted out of the *Base*, the Perpendicular will fall in the middle of the Remainder.



EXAMPLE.

By this Operation 8.8. are the parts of the *Base* between C, and D, or between D and G. Therefore 8.8. is the Point D, where the Perpendicular ought to fall, and its length is found by *Prob.* 8.

E F 13, E G 11 } Sub. — 2 Rests.
13, 11 } Add. — 24 Sum.

Analogy is this.
20 : 24 :: 2 : 2.4.
2.4 Sub.
17.6 Remains.
8.8 the ½ parts the *Base*.

Euclid 13. 2.

From the Sum of the Squares of E F, and F G, substract the Square of E G, and divide half the Remainder by F G, the Quotient is F D, by *Euclid* 13. 2.

PROBLEM XIII.

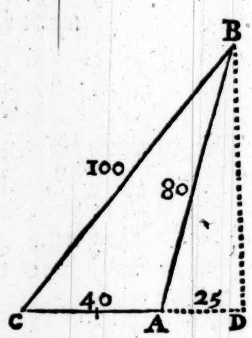
Three Sides of an Obtuse Angled Triangle being known, to find how far the Perpendicular falls without the Obtuse Angle.

THEOREM.

From the Square of B C, substract the Square of A B, and A C, and divide half the Remainder by A C, the Quotient is A D, by *Euclid Prop.* 12. 2.

EXAMPLE.

Thus the Square of A B 80, is 6400; and of A D 40 is 1600; the Sum of these two Squares is 8000; which substracted from the Square of B C 100, *viz.* 10000, there remains 2000, the half of which is 1000; which divided by A C 40, the Quotient is A D 25 Parts; and by *Prob.* 8. the Length of the Perpendicular B D will be found.



Otherways, Divide the Side A C, into two equal parts; and one of these parts will be the Length of AD; and D is the Point where the Perpendicular B D must fall.

PROBLEM XIV.

To Measure any manner of Triangle whatsoever.

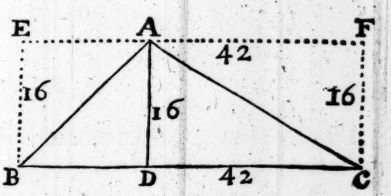
THEOREM.

Every Triangle is half that Long Square, whose Length and Breadth is equal to the Perpendicular and Base, or Side cut by the Perpendicular thereof. Therefore from one of the greatest Angles, draw a Perpendicular, as AD; which Multiply in half the Base, or Side cut thereby, and the Product is the Area.

Or, Multiply the whole Base, by half the Perpendicular, and that Product is the Area.

EXAM-

EXAMPLE.



Admit ABC, be a Triangle to be Measured, whose Base BC, is 42 Perches, and the Perpendicular AD 16, as they are both taken from one Scale; now I Multiply the half Base 21, by the whole Perpendicular 16, and the Product is 336, for the Area of the Triangle ABC.

Or if you Multiply the whole Base 42, by 8 the half Perpendicular, the Product is 336, as before.

Or else Multiply the whole Base 42, by the whole Perpendicular 16, the Product will be the Content of the Long Square EFCB, which is 672, whose half is 336, the Area, as before.

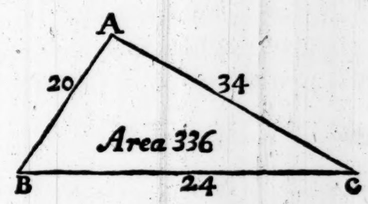
PROBLEM XV.

To Measure any manner of Triangle, the three Sides being given without finding the Perpendicular.

THEOREM.

Add together all the three Sides, and take half the Total, and from this half Substract every Side, which call the three Differences; Multiply these three Differences, and the half Sum continually together, the Square Root of this last Product is the Area thereof.

EXAMPLE.



Admit the three Sides of the Triangle are 42, 34, 20, the Sum is 96, the half Sum is 48; from which Substracting the several Sides, the Differences are 28, 14, 6: First then Multiply 48, by 28, and the Product is 1344; which Multiplied by 14, that Product is 18816; This Multiply by the last Difference 6, and the Product is 112896, whose Root 336, is the Area of the Triangle, agreeing with all the Operations in the last Problem.

PROBLEM XVI.

To Measure a Trapezium, *when none of the Sides are Parallel.*

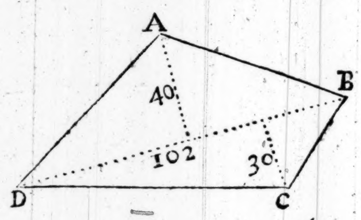
THEOREM.

A *Trapezium* is a Figure consisting of four unequal Sides, as the Figure ABCD; to Measure which *Trapezium*, draw the Diagonal D B; so is the Figure divided into two Triangles, which you may Measure according to the *Fourteenth Problem*, by letting Perpendiculars fall from the Angles A, and C, upon the Base Line D B.

But with more brevity, you may add the two Perpendiculars together, and Multiply the Sum of them by half the Base, and the Product will be the Area of the *Trapezium*, A B C D.

EXAMPLE.

The Sum of the two Perpendiculars is 70, and half the Base is 51; which Multiplied together, makes 3570, for the Area of the *Trapezium* ABCD.



PROBLEM XVII.

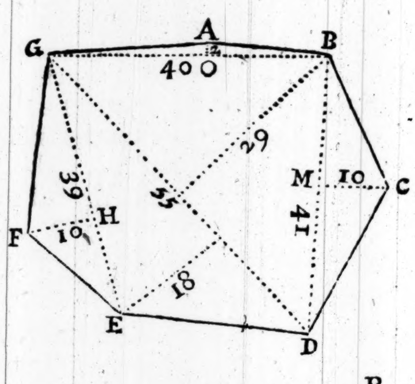
To Measure any Irregular Polygon, or Plot of Ground.

THEOREM.

First, Take care that the whole Plane be divided into *Trapeziums* and Triangles according to your own Fancy, and as the Nature of the Thing will bear; then Measure those *Trapeziums* and Triangles, as is directed in the *14th* and *16th Problems* beforegoing, and add the several Contents together; so will the Sum produce you the whole Content of that Irregular Figure.

EXAMPLE.

Admit this Figure noted with the Letters A B C D E F G, be the Irregular Plot given; and because it is not in any of the Shapes before given, therefore the best way is to reduce it into *Trapeziums* and Triangles, which is done by drawing the Lines DG,



BD, GB, and GE, so is the Figure divided into one *Trapezium*, and three Triangles, as the Figure directs.

Now to find the Content of this Figure, Measure the *Trapezium* and Triangles as before directed, and add them together as followeth.

Trapezium	EGBD	1292.50
Triangles	BDC	205.00
	EGF	195.00
	ABG	40.00
The Area of the Figure ABCDEFG		1732.50

PROBLEM XVIII.

To Measure any Regular Polygon.

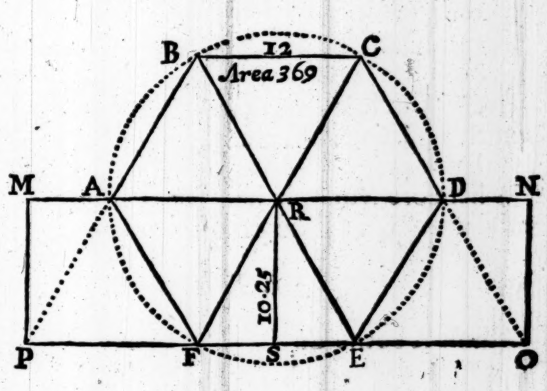
Every Polygon is equal to that Long Square, whose length is half the Perimeter, and Breadth equal to a Perpendicular drawn from the Center to the Middle of any one of the Sides thereof. Therefore,

Theorem.

From the Center, to any of the Sides, by *Problem* 3. of the *First Part*, let fall a parpendicular or else find it *Arithmetically* by *Problem* 11. of this Part; by which Perpendicular, half the Perimeter being Multiplied, the Product sheweth the Area.

EXAMPLE.

Admit ABCDEF, to be a *Hexagon* to be Measured, whose Side is 12, and Perpendicular is 10.25, or $10\frac{1}{4}$; which Multiplied by 36, half the Perimeter, the Product is 369 for the Area of the whole Polygon.



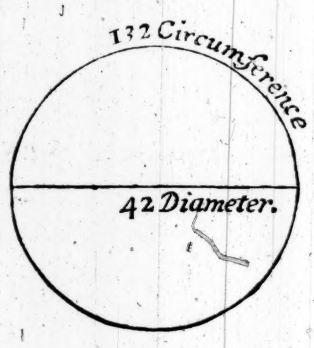
This Theorem is Demonstrated by the Long Square MNOP; for the whole Polygon being 6 Equilateral Triangles, the Long Square is also 5 such Triangles, and 2 Right Angled Triangles equal to another Equilateral Triangle; so that the Long Square is in all six Equilateral Triangles, equal to the whole Polygon.

PROBLEM XIX.

The Diameter of a Circle being given, to find the Circumference.

THEOREM.

Every Circumference is more than triple his Diameter; by such Proportion it is more than $\frac{10}{71}$, and less than $\frac{1}{7}$; but the nearest Rational Number, between the Diameter, and the Circumference is as 7 to 22. Therefore if you Multiply the Diameter by 22, and Divide the Product by 7, the Quotient will shew the Circumference.



EXAMPLE.

Diam. Circum. Diamet.
If 7, be 22 : what is 42? (132. *Circumference.*

Contrariwise; to find the Diameter: As 22 to 7, so is 132 to 42, for the Diameter: Therefore to find the Diameter, Multiply the given Circumference always by 7, and divide the Product by 22, and the Quotient sheweth the Diameter.

PROBLEM XX.

To Measure a Circle several ways.

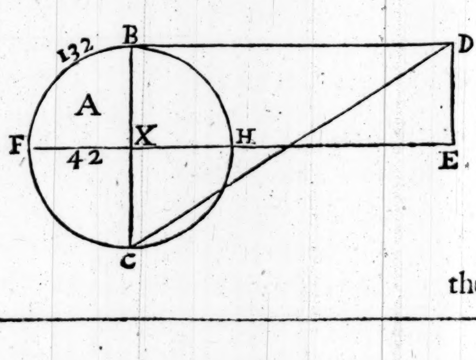
THEOREM.

Every Circle is equal to that Oblong or Long Square, whose Length and Breadth, are equal to half the Circumference and Semidiameter.

Wherefore Multiply half the Perimeter of the Circle, by its Semidiameter, and the Product is the Area thereof.

EXAMPLE.

Admit A be the Circle to be Measured, whose Diameter FH, or BC, is 42; and the Circumference BHCF, 132, by the last *Problem*; whose half 66 being Multiplied by



the

the Semidiameter X B 21, it produceth 1386 for the Area of the Circle.

☞ *Note*, Also every Circle is equal to that Right Angled Triangle, whose two containing Sides, one whereof is equal to half the Circumference, and the other to the Diameter.

Therefore if you Multiply the Diameter 42, by the fourth part of the Circumference 33, it produceth 1386, for the Area, as before.

By which you may see that the Oblong B D E X, is near equal to the Circle A, as likewise the Rectangled Triangle C B D.

☞ *Note*, Also every Circle is $\frac{11}{14}$ of the *Geometrical* Square about it, which is made of the Diameter; therefore if you Multiply the Diameter by $\frac{11}{14}$ of the Diameter, the Product is the Area.

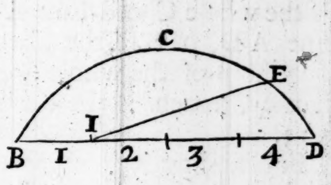
☞ *Note*, Otherways Square the Diameter, and Multiply that by 11, and Divide that Product by 14, the Quotient is the Area.

PROBLEM XXI.

To find the Length of an Arch-Line of a Circle, Geometrically.

THEOREM.

Let B C D be an Arch-Line given, whose Length is required: First, draw the Chord-Line B D, which must always be Divided into 4 equal parts, as you see Numbred with 1, 2, 3, 4: Then take one of those Parts, and set it from D to E, upon the Arch-Line: That done, draw a Line from the Point E, to the first Division, which shall be I E; this Line is



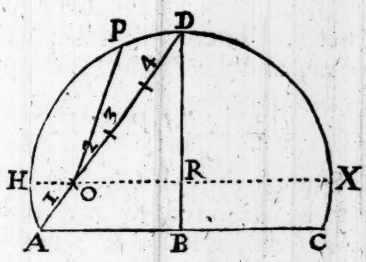
half of the Arch-Line B C D, whose double shall be the Length of the Arch-Line required.

PROBLEM XXII.

To find the Length of an Arch-Line greater than a Semicircle.

THEOREM.

When the Portion of the given Circle is greater than a Semicircle, whose Extent is desired: First, therefore divide the said Arch into two equal parts, as D B; then divide the Chord-Line A D, into four equal parts; by help whereof, draw the Line O P, as was



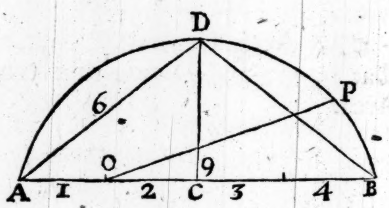
ſhewed in the laſt *Problem*, which Line is half the Arch A D, by conſequence four times the Line O P, is equal to the Segment A D C.

PROBLEM XXIII.

To find the Length of the Arch of any Segment of a Circle, Arithmetically.

THEOREM.

Firſt draw the Chord of the Arch-Line, as A B, which divide in half at C; from which Point, raiſe the Perpendicular, or Verſed Sine C D, which ſhall divide the Arch A D B, into two equal parts at D; then from D to A, draw the half Chord A D of its Segment; as likewiſe from D, to B.



EXAMPLE.

Then upon a Scale of equal parts, take off the Length of the half Chord of the Arch A D, or B D, which let be *6*; then take off the whole Chord-Line A B, which let be 9; then from eight times A D, or B D, the Chord of the half Segment; ſubduct A B, the Chord of the whole Segment, and divide the Remainder by 5, the Quotient is the Length of the Arch-Line A B D, which is 13.

For finding it another way *Arithmetically*, you may conſult *Prob.* 24. of *Babington's Geometry*.

PROBLEM XXIV.

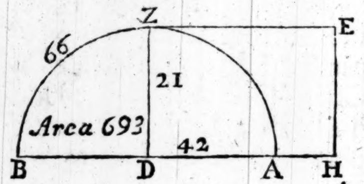
To Meaſure a Semicircle.

THEOREM.

Every Semicircle is near equal to that Long Square, whoſe length and breadth is equal to half the Arch-Line and the Semidiameter. Therefore Multiply half the Arch-Line by the Semidiameter, and the Product is the Area of the Semicircle.

EXAMPLE.

Suppoſe the half Circle A Z B, is to be Meaſured, whoſe Arch-Line AZB, is found *66*; now I Multiply the half thereof 33, by



the

the Semidiameter Z D 21, and it produceth 693 for the Area of the Semicircle, to which the Oblong Z E H D is near equal.

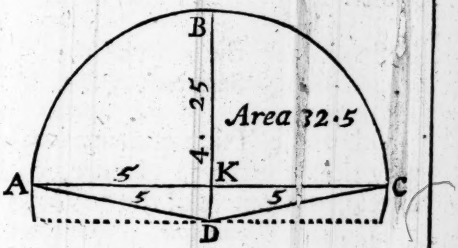
PROBLEM XXV.

To Measure any Portion of a Circle.

Note, That six sorts of Portions of Circles may be given to be Measured; the Reason whereof is grounded upon this Theorem following.

THEOREM.

Every portion of a Circle, which is contained under two Semidiameters, and one Arch-Line, is equal to that Long Square, whose length and breadth is equal to the Semidiameter, and one half of the Arch-Line.



Therefore in any such portion, first find out the Center of that Circle, whereof the Arch-Line is a part of the Periphery, by *Prob.* 13. of *Part* I.

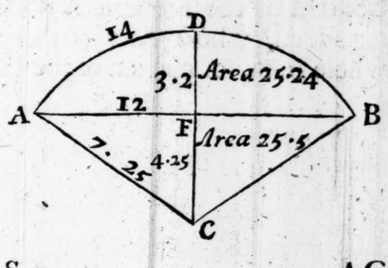
Or else find the Diameter *Arithmetically* thus: Multiply half the Chord-Line, *viz.* A K 5 by it self, which makes 25; then divide that Product by 4.25, the Versed Sine K B, the Quotient whereof will be 5.882; then if you add 4.25 the Versed Sine to the Quotient 5.882, the Sum will be 10.132, for the Diameter of the Segment ABC; then Multiply half the Arch-Line by the Semidiameter, and the Product sheweth the Area.

EXAMPLE *of the First.*

Let A B C D be a Portion, or Sector of a Circle to be measured, the Arch-Line A B C is found (by *Prob.* 22. of this part) 13; the half whereof being Multiplied by 5 the Semidiameter A D, or C D, produceth 32.5 for the Area of the Sector A B C D.

EXAMPLE *of the Second.*

Let A D B be the Segment of a Circle to be Measured: Now for that it is not at the first giving to be Measured, included with two Semidiameters, and an Arch-Line, you must therefore find the Center C, whereof the Arch-Line, or Segment A D B, is a part of the Periphery, by the last *Problem*; then draw the two Semidiameters



A C and B C; so shall you include the Triangle A B C, more than the Segment A D B: Now first Measure the whole Figure A C B D by the last *Proposition*; then Measure the *Isosceles* Triangle A C B, and from the Content of the whole Sector A C B D, substract the Content of the Triangle A B C; and the Remainder is the Area of the Segment A D B.

The Operation.

Take ½	14	the Arch-Line ADB
	7.25	the Semidiamet.
	7	the ½ of the Arch
	50.75	Area of the Sector
Substr.	25.5	Area of the Tria.
Rests	25.25	the Area of the Segment A D B

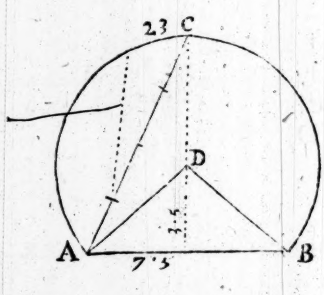
The Perpend. EC	4.25	
The Base AB	12	
Take ½	51.00	*Prod.*
The ½ of the *Prod.*	25.5	Is the Area of the Triangle A B C required.

Otherwise, The Segment of a Circle may more readily be found very near the truth at once, without finding the Center of the Circle, or Content of the Sector as followeth.

By the last *Example*, draw the Chord-Line A B, and Measure the length thereof, which is 12; then Measure the Perpendicular D E, which is 3.2: Now if you Multiply the Perpendicular 3.2, by ⅔ parts of the Chord-Line A B, which is 8; you shall have 25.6 for the Area of the Segment A D B, differing very little from the former.

EXAMPLE of the Third.

Let A B C be a portion of a Circle to be Measured: Now for that the whole consisteth of an Arch-Line, and a Chord-Line, therefore first find out the Center D; then draw the two Semidiameters A D, and B D, and find the Content of the Figure A B D and C, (omitting the Triangle A D B) by Multiplying ½ of the Arch-Line ACB, which is 23, the ½ of it is 11.5, which Multiplied by the Semidiameter 6.25, produceth 71.875, for the Area of A B D and C, to which the Content of the Triangle A B D being added, whose Area is 26.25, maketh in all 98.125, for the whole Area, or portion of the Circle A B C, as was required.



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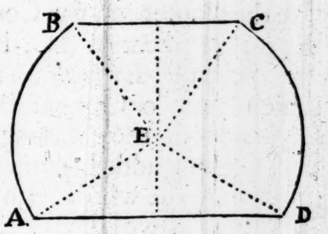
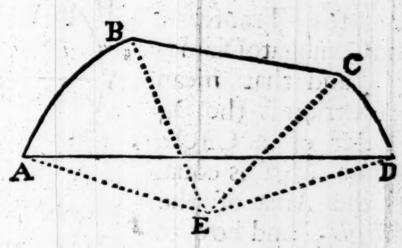
EXAMPLE of the Fourth.

Let A B C D be a portion of a Circle to be Meaſured: Now for that the Perimeter thereof conſiſteth of two Arch-Lines, and two Chord-Lines, therefore firſt, the Center is to be found, which is E; from which draw the four Semidiameters, as E B, E C, E D, & E A; ſo ſhall you Reduce that Figure, or portion of a Circle, into the two Sectors A B E, and D C E, being both equal one to the other; therefore the one being Meaſured, *viz.* The Area thereof, is the Area alſo of the other; likewiſe it partakes of two Triangles, *viz.* B E C, and A E D, which muſt both be Meaſured ſeverally, becauſe they are not equal; and theſe four Areas thus found, and added together, is the Area, or Content of the whole Figure A B C D; which was the thing required.



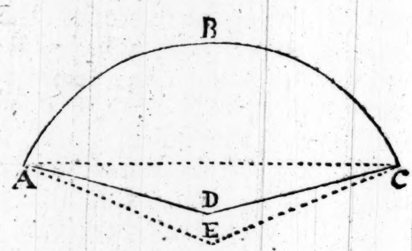
EXAMPLE of the Fifth.

Let A B C D be a portion of a Circle to be Meaſured, being incloſed, in which are two Chord-Lines, and two Arch-Lines; but whereas in the laſt *Example*, the Center was within the Figure, and in this the Center is without; yet as in all the reſt, ſo in this, the Center is firſt to be found, which let be E; then draw the four Semidiameters, ſo ſhall you Reduce the Figure A B C D and E, into three Figures, *viz.* two Sectors; namely, A E B, and E C D, as alſo the *Iſoſceles* Triangle E B C; all which are to be Meaſured, as hath been before taught; and from the Total Content of all the three, the Area or Content of the Triangle A E D, is to be Subſtracted, and the Remainder is the Area, or Content of the Figure ABCD, which was required.



EXAMPLE of the Sixth.

Let ABCD be a Figure to be Measured: First, let the Center be found as before; then draw the Semidiameters AE and EC, so shall you include the Sector ABCE; that done, Measure the Content of the Contle, or Segment ABC, by the Second *Example*; to which Area, or Content, the Content of the Triangle ADC being added, maketh the Area of the whole Figure ABCD, as was required.

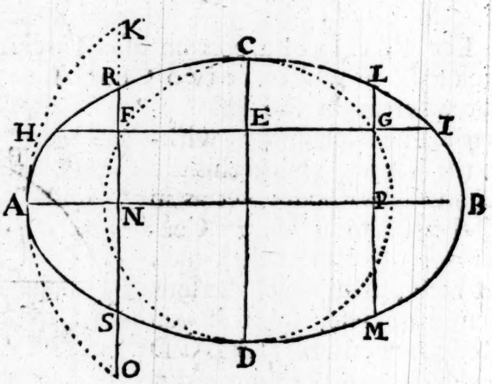


PROBLEM XXVI.

To Measure an Ellipsis, *or Oval, and its Segments.*

THEOREM.

For the Measuring of an *Ellipsis*, the best way is to Reduce it to a Circle, thus. Find a mean proportion between the greater and lesser Diameters of the *Ellipsis*, commonly called, the Transverse and Conjugate Diameters, and that mean proportion is the Diameter of a Circle, whose Area is equal to the Area of the *Ellipsis*; and how to Measure a Circle, is shewed in *Problem* 20, of this Part.



PROBLEM XXVII.

Given AB, and CD, the Diameters of an Ellipsis, *and CE the Versed Sine; to find the Segment HCI.*

THEOREM.

As CD=NP, the lesser Diameter, is to the Segment FCG,
So is AB, the greatest Diameter, to the Segment HCI.

As CD : FCG :: AB : HCI.

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PROBLEM XXVIII.

Given A B, and C D, the Diameters of an Ellipsis, and A N=P B, the Versed Sine, to find the Segment S A R.

THEOREM.

As A B, the Transverse Diameter, is to the Segment K A O,
So is C D, the Conjugate Diameter to the Segment S A R.

As AB : KAO :: CD : SAR.

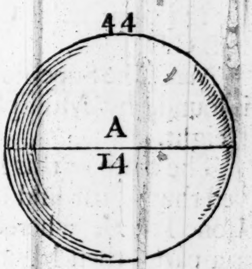
PROBLEM XXIX.

To Measure the Superficial Content of a Sphere, or Globe.

THEOREM.

Multiply the Diameter by the Circumference, the Product is the Superficial Content of the Globe, or Sphere.

EXAMPLE.



Admit A, be a Globe, or Sphere, whose Superficial Content, or Area of its Surface, is required; I Multiply the Circumference (which is gained by *Problem* 19.) or *Periphery* 44, by the Diameter 14, the Product is *616*, for the Superficial Content of the Sphere required.

PROBLEM XXX.

How to Measure the Superficies of a Cone.

THEOREM.

Multiply the Slant height by half the Circumference at the Base, the Product is the Conical Surface; to which if you add the Area of the Circle underneath, you shall have the whole Surface Content.

Note, That the most exact way would be to find the Perpendicular's height A B, instead of the Slant height A C, and to Multiply it by half the Circumference as before; which Perpendicular may be found, making the Circumference the Base, and the Slant height the Sides of an *Isosceles* Triangle; then by *Prob.*11. find the Perpendicular.

PROBLEM XXXI.

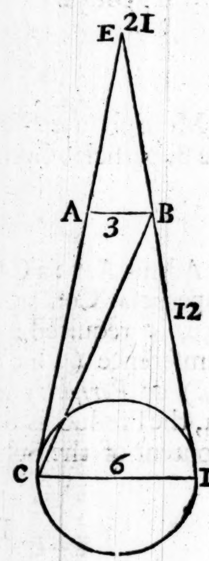
How to Measure the Superficies of the Frustum of a Cone.

Theorem.

Add the greater and lesser Circumference of the Bases together, $\frac{1}{2}$ of the Sum is an *Arithmetical* Mean, which Reduces the Frustum into a *Cylinder*; which half Sum, or Mean, Multiplied by its height, the Product is the Superficial Content of the Frustum.

EXAMPLE.

Let A B C D be the Frustum, or part of a Cone, whose Superficial Content is required, the Circumference of the greater and lesser Base being 6 and 3, which added is 9, the half is 4.5 for the *Arithmetical* Mean, for the Circumference of the Bases of a *Cylinder* at both ends; the which 4.5 Multiplied by 12, the height A C, the Product produces 54.0 for the Superficial Content of the Frustum A B C D.



Note The Superficial Content of a *Cylinder* is found, by Multiplying the Girth by the Height.

The truth of this last *Problem* may be proved thus: First find the Length of the whole Cone E C D, whereof the Frustum A B C D is a part; then having the whole height of the Cone, Measure first its Superficies by *Problem* 30; then Measure the Superficies of the top part, or lesser Cone, by the same *Problem*, and Substract the Content of the lesser, from the Content of the greater Cone; and the Remainder shall be the Content of the Frustum.

PROBLEM XXXII.

To Measure the Superficies of any Angular Pyramid, with its Frustums.

Theorem.

If the Sides, or Angles at the Base be all equal Measure; the Content of one side by *Prob.* 11. then Multiply that Area by the Number of all its Sides, and the Product is the Area of the whole Pyramid. But if the Sides be unequal, Measure them severally as

as ſo many Triangles, and the Sum of their Contents is the Sum of the whole Pyramid.

But if you are to Meaſure the Fruſtum of ſuch a Pyramid, find an *Arithmetical* Mean, betwixt the broader and narrower end of one Side, or Square; and that Mean, Multiplied by its height, is the Content of one of the Sides, which being all equal, Multiply that Content by the Number of all the Sides, the Product is the Content of the whole Fruſtum.

If the Sides be unequal, Meaſure them ſeverally, and the Sum of all their Contents is the whole Area, or Content.

The End of the Second Part.

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GEOMETRY.

PART III.

CONTAINING

The Dividing (or Cutting off) both Right-Lined and Irregular Figures, into as many Parts, Equal or Unequal, as shall be required.

PROBLEM I.

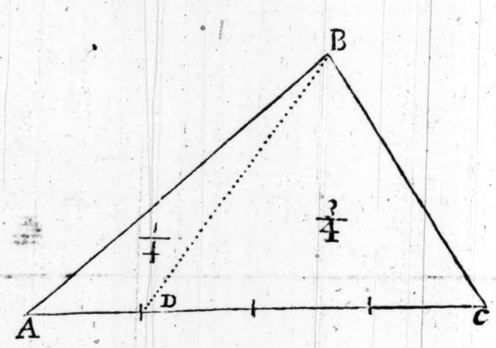
To cut off from a Triangle any Parts, as $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{5}$, &c. *with a Line issuing from any Angle assigned.*

THEOREM.

TRiangles, consisting of equal Bases, and in the same Parallel, are equal; Therefore take $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{5}$, *&c.* of the Line opposite to the Angle; draw a Line, which shall include a Triangle to retain the Parts required.

EXAMPLE.

Admit A B C, to be a Triangle, whose $\frac{1}{4}$ part is required to be cut off, with a Line issuing from B, to cut the Line A C; and that A B be one side of the new Triangle; Then let the $\frac{1}{4}$ part of the Line A C be taken, the which endeth in D, and let the Line B D be drawn, which includeth the Triangle A B D, which is the $\frac{1}{4}$ part of the Triangle A B C; and then consequently the Triangle B C D, is $\frac{3}{4}$ parts of the Triangle A B C, *&c.*



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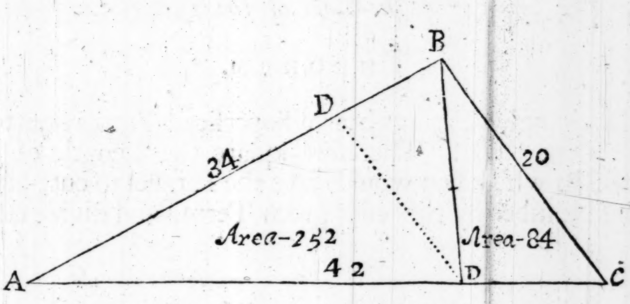
PROBLEM II.

To cut off from a Triangle any number of Measures or Parts, as 4, 6, 8, 32, &c. *with a Line issuing out of the Angle assigned.*

THEOREM.

First, Measure the Area of the whole Triangle, then multiply the side opposite to the Angle assigned, by the parts to be cut off,



and divide the Product by the Area of the whole Triangle; the Quotient sheweth how much you shall cut off, to make a new Triangle to retain the Parts required.

EXAMPLE.

Let ABC be a Triangle given, and let the Proposition be to cut off 84 parts, with a Line issuing from the Angle B, and falling on the Line AC, and making BC, one of the sides of the new Triangle; first, the whole Content of the whole Triangle ABC, is found to be 336: Having proceeded thus, let 84 be the Numerator, and 336 the Denominator, which being abbreviated thus, $\frac{84}{336}$ | $\frac{42}{168}$ | $\frac{21}{84}$ | $\frac{3}{28}$, $\frac{1}{4}$ of the Content; then proceed in all respects as you did in the last Problem; and you shall find the Triangle BCD, to contain 84 parts of the Area of the Triangle ABC, which was required.

Arithmetically *Performed.*

First, The Content or Area of the Triangle ABC, being found to contain 336, and the Line AC is 42; then say by the Rule of Proportion, as the whole Area 336, is to 42; so is the lesser Area 84, to a fourth Number, which is found $10\frac{1}{2}$ in the same Parallel; which set from C towards A, which falleth in D: Then draw the Line BD, which Triangle BCD, contain 84 parts, the thing required.

Otherwise, Arithmetically.

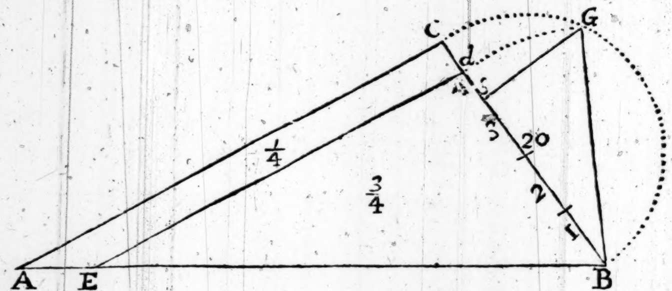
Double the parts to be cut off, and they make 168, which divide by the Length of B C 20, the Quotient is 8.4; at which diſtance draw the Line D D, and afterwards the Line B D, which ſhall make the Triangle B C D, to contain 84 parts, as before.

PROBLEM III.

To cut off from a Triangle, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{3}{5}$, &c. *with a Line Parallel to any one of the Sides of the* Triangle.

THEOREM.

All Equi-angled Figures bear a Superficial Proportion to their correſpondent Sides: Therefore ſquare the Length of one of the Sides, in which you would have the Parallel to cut, and multiply the Number by the leſſer given Term, and divide that Pro-



duct by the greater, and from that Quotient extract the Square-Root, which ſheweth how much of that Line you ſhall take to make one Side of the new Triangle; and from that Point, where thoſe Meaſures do end, draw a Line parallel to the Side aſſigned, which ſhall include a Triangle to contain the parts requir'd.

EXAMPLE, Arithmetically.

Admit A B C to be a Triangle, from whence $\frac{3}{4}$ is to be cut by a Line parallel to A C; Firſt then, the Line B C, which is cut by the parallel Line, is 20, whoſe Square is 400, whence $\frac{3}{4}$ thereof is 300, whoſe Square Root is $17\frac{1}{3}\frac{1}{4}$, near rational; which ſet from B towards C, ending in *d*, from which point let a Line be drawn parallel to A C, which cutteth the Line A B in E; ſo is the Triangle B D E, $\frac{3}{4}$ of the Triangle A B C, required.

EXAM-

EXAMPLE II.

The aforegoing Problem performed Geometrically.

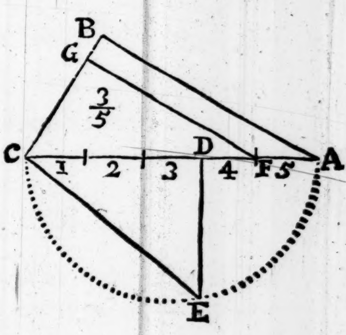
Admit ABC, in the aforegoing *Problem*, to be a Triangle, from whence $\frac{3}{4}$ parts is to be cut off by a Line parallel to AC, in the same Order; first then, on the Line BC, describe a Semi-Circle, which Line BC divide into 4 equal parts: Note where 3 of them do end, in *f*; on which point raise the Perpendicular *f* G, and from that point G, draw the Line GB, which set from F, towards C, which terminates in *d*, by which point draw a Line parallel to AC, as *d* E; so is *d* EB, $\frac{3}{4}$ of the Triangle ABC required.

Note; After this manner you may reduce any Plot into any Proportion, either greater or lesser, as shall be required.

EXAMPLE III.

A Third *Example of the former Problem, as followeth.*

Admit ABC be a Triangle given, and it is required to cut off $\frac{3}{5}$, by a Line parallel to AB: First, on the Line AC describe, the Semi-Circle AEC; then divide the Line CA, into 5 equal parts, and upon 3 of those parts erect the Perpendicular DE, which cutteth the Arch-Line in E; then set the Line CE, from C to F; and from thence draw the Line FG, parallel to AB; so will the Triangle CGF contain $\frac{3}{5}$ of the Triangle ABC, as was before required.



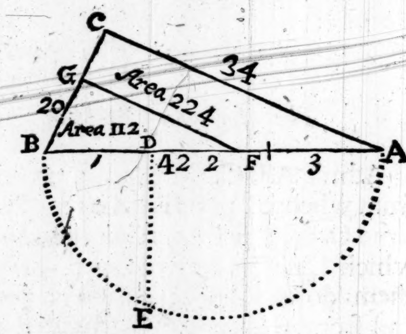
PROBLEM IV.

To cut off any number of Parts, as 20, 40, 60, &c. *in a* Triangle, *proportional to the* Triangle *given, with a Line parallel to any Side appointed.*

THEOREM.

First, Measure the whole Triangle, then square any of the Sides, in which you would have the Parallel to cut; that Square Number multiply by the parts given to be cut off, and divide the Product by the Area of the whole Figure, out of which Quotient extract the Square-Root; and it sheweth how much you shall

take of that Side the Triangle, to make a New Triangle; with which Measure found, work as in the last *Proposition*, by the first *Example*.



EXAMPLE.

Let A B C be a Triangle, from which 112 is to be cut off with a Line parallel to the Line C A; The Triangle being measured, and found to be 336, then put 112 over it, for the Numerator; and 336 under it, for the Denominator; and by abbreviating it you shall find the same to be $\frac{1}{3}$: then having described the Semi-Circle on the Line A B, divide the Line A B into 3 equal parts, and from one of them erect the Perpendicular D E; then take the Distance from B to E, and set the same from B, towards A, which endeth in F; by which point draw a Line parallel to A C: So the Triangle B G F doth contain 112, as was required.

Arithmetically *Performed*.

First, Square the Side B C 20, which makes 400; then say, as 336 is to 400, the Square of that Side, so is 112 to $133\frac{1}{3}$, whose Square-Root is $11\frac{1}{3}$, near rational; which is the Distance from B to G; so if you draw from that point at G, a Line parallel to A C, you have the Triangle B F G, which containeth 112, as before.

PROBLEM V.

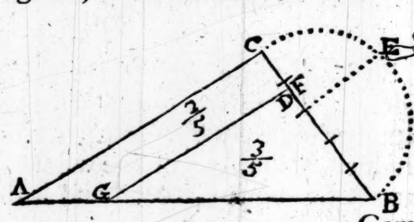
From a Triangle *given, to lay the Parts cut off in a* Trapezium; *if there be a Proportion given between the Parts cut off, and the whole Figure.*

THEOREM.

Substract the lesser from the greater, then with the Remainder work as before is taught.

EXAMPLE.

Let the Triangle A B C be given, from whence $\frac{2}{5}$ is to be cut off in a *Trapezium*: First then, on the Line C B describe a Semi-Circle; then divide C B into 5 equal parts, and of 3 of them from B, erect the Perpendicular DE; then, setting one Foot of your Com-



Compasses in B, extend the other to E, which Distance set off from B towards C, which endeth in F; by which point draw a Line parallel to A C: So I include the Triangle G F B, to contain $\frac{3}{5}$ of the whole; and consequently the *Trapezium* A C F G, doth contain $\frac{2}{5}$ of the same, as was required.

Arithmetically *Performed.*

First, Take $\frac{3}{5}$ from the whole, the remainder will be $\frac{2}{5}$; then by the last Problem make the Triangle G F B to contain $\frac{3}{5}$, and then it will follow, that the Trapezium A C F G must contain $\frac{2}{5}$ of the whole Triangle, which was required.

PROBLEM VI.

To cut off from a Square any Parts appointed in a Parallelogram.

THEOREM.

Divide the Parts to be cut off, by the side of the Square; the Quotient sheweth how much of the side you shall take, from the side of the Square for the Breadth of the Parallelogram; at which distance draw a Parallel Line; which shall include the Parallelogram required.

EXAMPLE I.

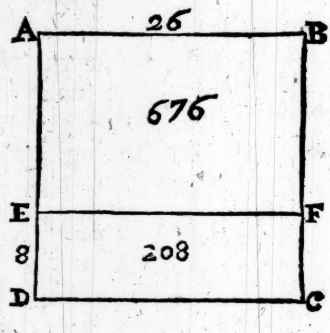
Admit A B C D to be a Square given, whose side is 20; from whence 160 parts is to be cut off with a Line Parallel to C D, so that C D makes one side of the Parallelogram; then work as is before taught, and draw the Line E F; which includeth the Parallelogram C D E F, and Contains 160, the parts required.

Note; And if you would have cut off $\frac{2}{3}$ $\frac{3}{5}$, *&c.* then you should have divided the Square side to be cut off into these proportional parts, and so by those parts draw a Parallel Line which would have included a Parallelogram to have contained the parts proportionable.

Another Example of this kind.

EXAMPLE. II.

Let the Square given be A B C D, containing 676 parts, and it is required to cut off 208 parts with a Line Parallel to C D, to be laid out next unto the same; first divide 208, by the side of the Square 26, and the Quotient is 8, which distance set from C to F, and from D to E; then draw the Line E F, which shall include the long Square or Parallelogram C D E F, to contain 208 parts, which is the thing inquired after.

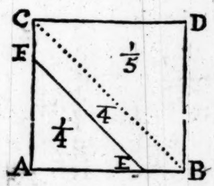


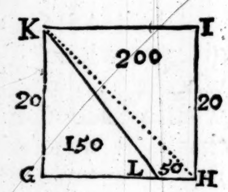
PROBLEM VII.

To cut off from a Square any Parts assigned, and to make those Parts into a Triangle; *wherein you must Note, that the Parts so cut off may not exceed* $\frac{1}{2}$ *of the Square, if they do, the Remainder will then be a* Triangle.

THEOREM.

To work this, draw a Diagonal-Line to the Square; that being done, the Square is reduced into two Right-Angled Triangles; then may you from either of the Triangles which is assigned, cut off any Number of Parts therein, by the Rules concerning Triangles beforegoing; either by a Line issuing out of an Angle, or with a Line parallel to any one of the Sides.





EXAMPLE.

From the Square A B C D, let there be cut $\frac{1}{4}$ of the Area, with a Line parallel to the Diagonal B C; then Note, $\frac{1}{4}$ of the Whole, is $\frac{1}{2}$ of the Half; therefore the Proportion standeth thus: From the Triangle A B C, let there be cut $\frac{1}{2}$, with a Line parallel to B C, which is found by the third *Problem* of this Part; which will be the Triangle A E F, which is $\frac{1}{4}$ of the Square A B C D, the thing required.

EXAM-

EXAMPLE II.

Again; the Square GHIK, being found to be 400; I desire to cut off 150 parts, with a Line issuing out of the Angle K, and falling on GH, which is performed by the foregoing Directions, as in the Figure.

Note; But if you were to cut any parts from a Square greater than the half, and to lay those Parts in a Trapezium; you must substract the Parts to be cut off, from the Content of the whole Square, and cut off the Remainder in a Triangle, as before directed: So shall the Trapezium remaining contain the Parts required to be cut off.

PROBLEM VIII.

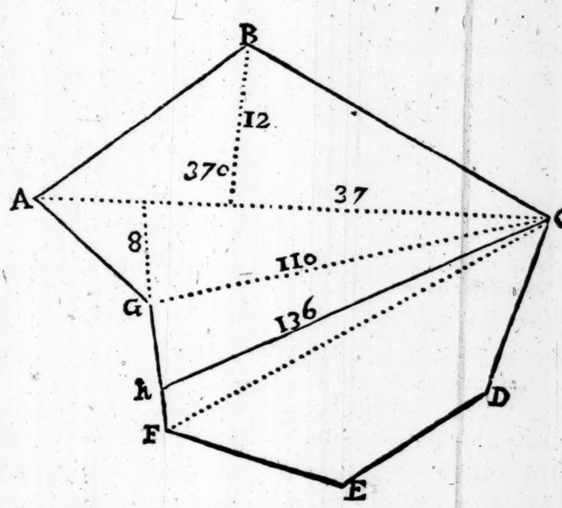
From an irregular Figure to cut off any Parts required.

THEOREM.

Measure so many Triangles lying next to the Side assigned, till you have something too much; then by the *first* and *second Problem* of this Part, cut off the Overplus from the last Triangle; So shall you have a Figure to contain the Parts required.

EXAMPLE.

Admit ABCDEFG to be a Plot, from whence 480 parts are to be cut off, with a Line issuing from C, and to lie towards the Side AB: First, let the Trapezium ABCG, be measured,



whose Area is 370, which added to 136, the Area of the Triangle CFG, maketh 506, which is too much by 26, which 26 let be cut off from the Triangle CFG, by the Line C*h*; so doth

the Figure A B C h G, contain 480, the Parts required to be cut off.

Note; This *Problem* is very material in the Practice of Surveying, in dividing and laying-out Grounds, whether into Parts equal or unequal; which every Surveyor ought well to acquaint himself with.

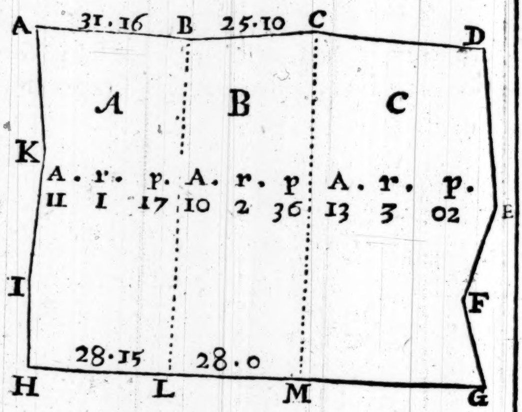
For the better underſtanding this Point, we will ſuppoſe a Point given in the Perimeter of the Plot, from which the ſaid Plot is to be divided into as many equal parts as ſhall be required; Firſt, Meaſure the Area of the whole Plot, then divide that Content by the Number of Parts, and the Quotient ſheweth how many Meaſures each part ſhall contain; then cut off each part ſeverally, as you are taught in the preceding Work.

PROBLEM IX.

To divide a Common Field or Paſture, into as many Parts as ſhall be required; either according to the Number of Beaſe-Commons each Man poſſeſſeth, or according to each Perſon's Proportion of Rent.

EXAMPLE I.

Let this Figure noted with the Letters ABCDEFGHIK, be a Common Field or Paſture, in the Uſe and Occupation of 3 Men, *viz. A.B.C.* and it is mutually agreed by them all, that each Man ſhall have his proportion of Ground laid out, according to his Quantity of Common in the ſame place.

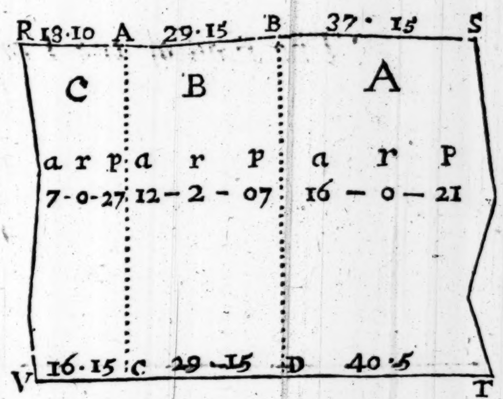


First, Meaſure the whole Field, and it will be found to contain 35 *a.* 3 *r.* 15 *p.* or 5735 *Perches*; then conſider how many Beaſe-Gates there are in the Paſture, and divide the Quantity of the Field accordingly by the *Rule of Proportion*, thus; ſaying, If the whole Number of Beaſe-Gates of *A. B.* and *C.* give or belong to the whole Quantity of Perches in the Field 5735, what ſhall the Number of them belonging to *A.* be? and the Anſwer will be his Part; and ſo work ſeverally for each Man's Part: but we may ſuppoſe them thus; to *A.* 1817 *Perches*, or 11 *a.* 1 *r.* 17 *p.* to *B.* 1716 *Perches*, or 10 *a.* 2 *r.* 36 *p.* and to *C.* 2202 *Perches*, or 13 *a.* 3 *r.* 02 *p.* Then to lay out every Man's Plot, I divide the Figure by the Direction aforegoing, by the Lines B L and C M, which to lay out upon the Ground, take from

from your Scale the Distance on the Plot, between the Net-Angle and that beginning of your first Line, as H L 28.15, then measure out the Distance on the Ground from the Angle H to L, also from the Angle A, measure upon the Ground 31.16 to B, then draw the Line B L, and make Dots or Marks; again, take from your Scale the Quantity of L M, 28.00, which measure on the Ground from L to M, and there set a Mark; and in like manner measure from B to C upon the Ground, 25.10, equal to B C upon the Plot, drawing the Line C M: So is your Plot divided according to every Man's just Quantity and Proportion, according to the Number of Bease-Gates.

EXAMPLE II.

But suppose it were required to divide this Field between 3 Persons, *viz.* *A.* *B.* and *C.* according to each Man's proportion of Rent: As suppose the whole Ground to be 20 *pounds* a Year; whereof *A.* pays 9 *l.* *B.* 7 *l.* and *C.* 4 *l.* the Question is, how many Acres, Roods, Perches belong to each Man, according to his Proportion of Rent? which by the *Rule of Three* argue thus; (first for *A.*) if 20 *l.* the whole Rent, give 5735 Perches (being the Content of the whole Field in Perches) what will 9 *l.* give? *viz.* 2581 Perches, or 16 *a.* 0 *r.* 21 *p.* being the proportion of Ground belonging to *A.* for his 9 *l.* Rent: In like manner, *B.* will have 12 *a.* 2 *r.* 07 *p.* being his quantity of Ground proportionably for his Rent of 7 *l.* and *C.* for his 4 *l.* Rent will have 7 *a.* 0 *r.* 27 *p.* Then to lay out these parts upon the Ground, observe the Directions in the former Example, and as 'tis here explained by this Figure R A B S T V; Thus, 'tis easie to perceive how any thing in this kind may be effected.

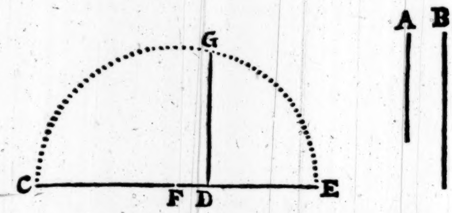


PROBLEM X.

To find a mean Proportion between any two Lines prescribed.

THEOREM.

Let A, B, the two Lines given, be so joined together, that they make both one straight Line, which let be the Line CDE; then divide the Line C E, into two equal parts, in the point F, and describe the Arch C G E, and raise the Perpendicular on the point D, where the two Lines are joined, till it come and join with the Arch in the point G;



which done, you have the Line DG, which is a Mean Proportion between the Lines A and B required.

The End of the Third Part.

GEO-

GEOMETRY.

PART IV.

BEING

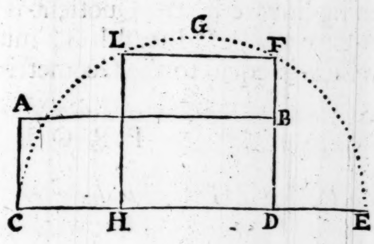
The Reduction of one Figure into another, keeping still the same Proportion.

PROBLEM I.

To Reduce a Long-Square into a Geometrical-Square, keeping the same Area or Proportion.

EXAMPLE.

LET the Long-Square ABDC, be given to be reduced into a Geometrical Square; First, therefore I add the Breadth to the Length, extending the Line to E, then describing the Arch CGE, erect the perpendicular at the joyning of the Lines at D, which extended to the Circumference, cutteth the Arch in F; So is the Perpendicular DF, the side of the Geometrical-Square FDHL; containing the Area of the long-Square ABDC, as was required.



Arithmetically *Performed.*

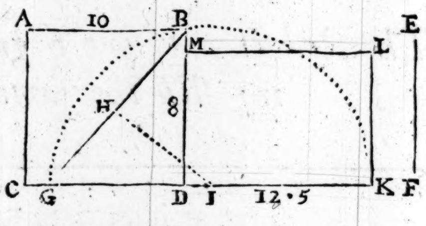
Multiply the Length by the Breadth of the long-Square, the Square-Root of that Product, is the side of the Geometrical-Square.

PROBLEM II.

To Reduce a Geometrical-Square into a Long-Square, whose Breadth is limited by a Right Line given.

EXAMPLE.

Suppose ABCD to be a Geometrical-Square, given to be reduc'd into a Long-Square, whose Breadth shall be equal to the Line EF: First, inlarge the side of the Square CD towards K; then setting down the Breadth from D to G, draw the Line GB, which divide into 2 equal parts in the point H, and on that point erect the Perpendicular, extending it till it cut the Line CK, in the the point I; upon which describe the Arch GBK, and from D to K is the Length of the Long-Square, whose Breadth is equal to the Line EF: And so have you the Long-Square KLMD, equal to the Geometrical-Square ABDC, which was required to be done.



Arithmetically *Performed.*

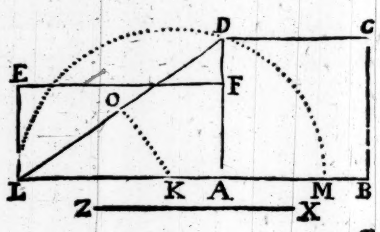
Square the Side AB, which is 10, which makes 100, and divide the Product by the Side DM=KL, the Breadth of the Long-Square 8, the Quotient is 12.5, for the Length of the Long-Square; whose Breadth 8, multiplied by 12.5 produceth 100, which is equal to the Geometrical-Square ABDC, required.

PROBLEM III.

To Reduce a Geometrical-Square into a Long-Square, whose Length is limited by a Line given.

EXAMPLE.

Let ABCD, be a Geometrical-Square given, to be reduced into a Long-Square, whose Length shall be equal to the Line ZX: First, continue the Line AB towards L, and set the Line ZX from A to L, drawing the Line DL, on the middle whereof erect the perpendicular OK, cutting the Ground-Line in K; where setting one Foot of the Com-



passes

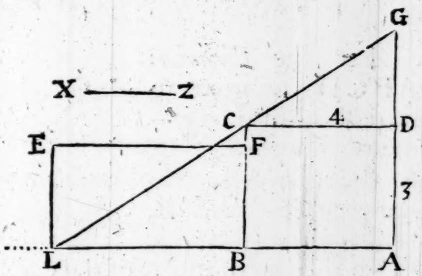
passes, extend the other to L, and describe the Semicircle L D M, which cuts the Line L B in M; so will A M be the breadth of the Long-Square sought; of which Breadth, and the given Length, make the Long-Square A F E L; which is equal in Area to the Geometrical-Square A B C D.

PROBLEM IV.

To Reduce one Long-Square into another Long-Square, whose Breadth is limited by a Line given.

EXAMPLE.

Let the Long-Square A B C D, be given to be reduced into another Long-Square, whose Breadth shall be equal to the Line X Z: First, Continue the Line A B towards L, and the Line A D towards G; then set the Line X Z from D to G, and draw out the Line G C, to cut the Ground-line A B, in L: So shall B L be the Length of the Long-Square; with which Length and the given Breadth X Z, make the Long-Square E F B L, which shall be equal to the Long-Square A B C D given, which was required.



PROBLEM V.

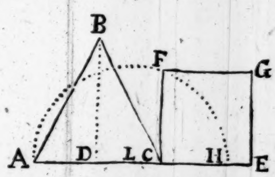
To Reduce a Triangle into a Geometrical-Square.

THEOREM.

In the given Triangle find the Mean Proportion between half the Perpendicular and the Base, and it gives you the Side of the Geometrical-Square, by *Problem* X. of *Part* III.

EXAMPLE.

In the Triangle A B C, the Perpendicular is B D, whose half set from C towards E, which endeth in H; then take the midst of A H, which is L, on which describe the Semicircle A F H; then raising the Perpendicular from the point C, observe where it intersects the Arch, which is in F: So that C F is the Side of the Geometrical-Square, containing the Triangle A B C.



Arithmetically *Reduced.*

Multiply the Perpendicular into half the Base, and from that Sum extract the Square-Root, which shall be the Side of the Square required.

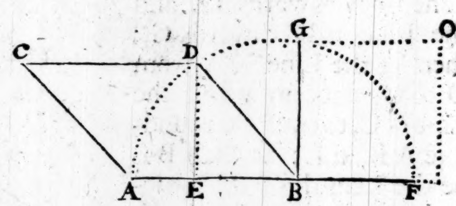
PROBLEM VI.

To Reduce a Rhombus *into a* Geometrical-*Square.*

THEOREM.

Open your Compaſſes of any one ſides length, and to it add the Perpendicular; the Mean proportion between the Perpendicular and the ſide, is the ſide of the *Geometrical*-Square, equal to the *Rhombus*.

EXAMPLE.



Let the *Rhombus* ABCD, be given to be reduced into a Geometrical-Square; firſt, to the ſide AB, add the perpendicular DE, which makes the Line AF; then on the point of their joyning B, Erect the perpendicular BG; which is the mean proportion between the Baſe, and the perpendicular; and is the ſide of a Geometrical-Square, containing the *Rhombus*; which was required.

Arithmetically *Reduced.*

Multiply the ſide of the *Rhombus* by the perpendicular, the Square-Root of that Product, is the ſide of the Geometrical-Square required.

PROBLEM VII.

To Reduce any Regular Polygon *into a* Geometrical-*Square.*

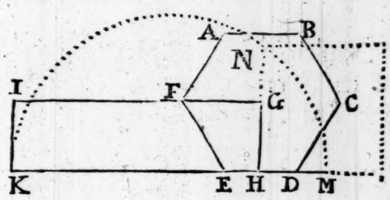
THEOREM.

To Reduce any Regular Polygon into a Geometrical Square, there is one General Rule, which is this: Find a mean proportion, between the Semi-perimeter and the Perpendicular; and that is the ſide of a Geometrical-Square, containing the ſaid Polygon.

EXAM.

EXAMPLE.

Let there be given the *Hexagon* ABCDEF: First, lay down the Semi-periphery, and to that add the Perpendicular GH, which makes the Line KM; so that I make that, the Diameter of the Semicircle KAM: Then raise the Perpendicular from H to N; so that HN is the Side of the Geometrical-Square required.



Note; In all Regular Polygons the Long-Square made of the Semi-periphery and the Perpendicular, is equal to the said Polygon, as appears by the aforegoing Figure.

Arithmetically *Reduced.*

Multiply the Perpendicular into the Semi-perimeter, the Square-Root of that Product is the Side of the Geometrical-Square.

PROBLEM VIII.

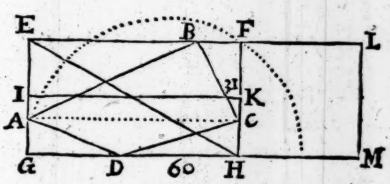
To Reduce a Trapezium *into a Geometrical-Square, Parallelogram, or Right-Angled Triangle.*

THEOREM.

If in a Trapezium a Line be drawn from any one Angle, and by that a Parallelogram be made, comprehending the Trapezium, and parallel to the Line so drawn; then half that Parallelogram is equal to the Trapezium; so that finding a Mean Proportion between the two Sides of the Long-Square, you shall have the Side of a Geometrical-Square required.

EXAMPLE.

Let there be a Trapezium given, as ABCD; first, draw the Line AC, then by the Angles B, D, draw two Lines parallel to AC, and from the extreme parts of one to the other, draw the Lines FH, and EG; so have you a Parallelogram double to the Trapezium; which if you cut in the half by the Line IK, you have the Parallelograms equal; so that finding a Mean Proportion between the two Sides thereof, you have the Side HF, which is the Side of the Geometrical-Square required.



So IKHG, or EFKI, are the Parallelograms; EGH, or EFH, the Right-Angled Triangle, and FHML the Geometrical-Square, equal to the Trapezium ABCD.

Arithmetically *Performed.*

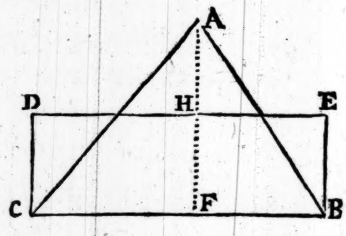
Multiply half GH 60, by FH, or EG 31, the Square-Root of that Product is the Side of the Geometrical-Square, equal to the Trapezium.

PROBLEM IX.

To Reduce a Triangle into a Parallelogram.

EXAMPLE.

Let ABC be a Triangle given to be reduced into a Long-Square: First, Draw the Perpendicular AF, which divide into 2 parts equally, as at H; take one half thereof, HF, for the Breadth, and the whole Base BC, for the Length of the Parallelogram DEBC, which is equal to the Triangle ABC, required.

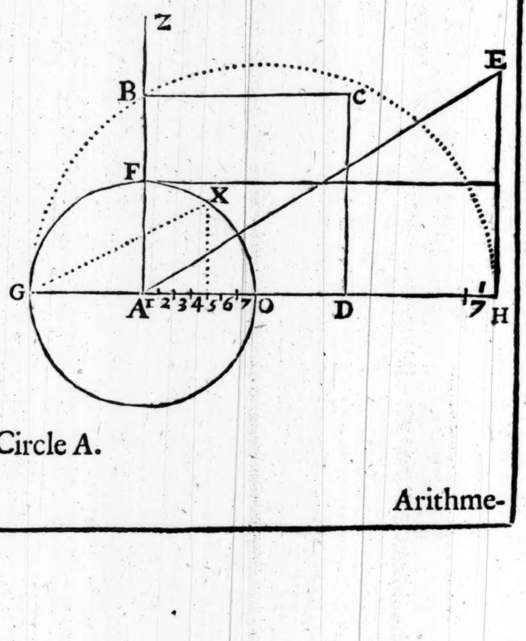


PROBLEM X.

To Reduce a Circle into a Geometrical-Square.

EXAMPLE.

Let A be the Circle given to be reduced into a Square; continue the Diameter GAO, towards H; then on the Center A, erect the Perpendicular AZ; then set three times the Semidiameter of the Circle, and $\frac{1}{7}$ part thereof, from A to H, and on the Line GH, describe the Semicircle GBH, which cutteth the Perpendicular in B; hence AB is the Side of the Square requir'd; therefore the Square ABCD is equal to the Circle A.



Arithme-

Arithmetically *Reduced.*

Note; That the Square-Root of the Area of any Circle is the Side of a Square equal to the Circle.

PROBLEM XI.

To Reduce a Circle into a Right-Angled Triangle.

EXAMPLE.

Again; The Circle may be reduced into a Right-Angled Triangle; for by the XX. *Problem* of the *ſecond* Part, every Circle is equal to that Right-Angled Triangle, of whoſe containing Sides, the one is equal to half the Periphery, and the other to the Diameter; and ſeeing now the Line A H is equal to half the Circumference, and the Line HE is equal to the Diameter of the Circle G O; therefore the Right-Angled Triangle A H E, is equal to the Circle A required.

PROBLEM XII.

To Reduce a Triangle *or a* Circle, *into a Long-Square.*

EXAMPLE.

According to *Problem* XIV. of *Part* II. every Triangle is half that Long-Square, whoſe Length and Breadth is equal to the Perpendicular, and the Side cut thereby; therefore let the Triangle given, be A H E, in the former Diagram, and it is required to reduce the ſame into a Long-Square; Take half the length of the Side of the Triangle H E, and divide the ſame into two equal parts at K; then is H K equal to A F, the Breadth of the Long-Square A F K H, equal to the Triangle A H E, or to the Circle A: For the Side A H, is equal to half the Circumference, and the Breadth A F, to the Semidiameter.

PROBLEM XIII.

To Reduce a Circle into a Square.

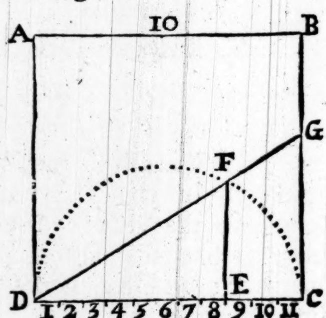
THEOREM.

Having laid down a Square, to be reduced into a Circle; Take any ſide of it, and divide it into 11 equal parts, deſcribing a Semicircle to it; then on 8 of thoſe parts erect the Perpendicular, which extend to the Circumference of the Semicircle; then draw a Line from the extreme parts of the Diameter, interſecting the Perpendicular in the Circumference of the Circle and

and continue that Line till it touch the side of the Square; so will that Line be the Diameter of a Circle, answerable to the Area of the Square.

EXAMPLE.

Let the Square A B C D be given, making C D the Diameter; then describe the Semicircle C F D; and having divided the Diameter into 11 equal parts, at the 8th part erect a Perpendicular E F: Then draw a Line from the extreme parts of the Diameter, which intersecteth with the Perpendicular in the Circumference at F; which being continued, gives the Line D G, the Diameter of a Circle, equal to the Square.



Arithmetically *Reduced.*

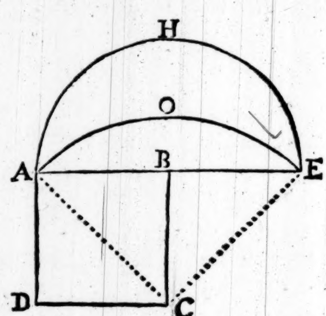
As 11 to the Square given; so is 14 to a fourth Number, the Square-Root whereof is the Diameter of the Circle (equal to the given Square) required.

PROBLEM XIV.

To Reduce a Square into a Lunular Form, and the contrary.

EXAMPLE.

Let A B C D be a Square, given to be reduced into a *Lunula*; First, draw the Diagonal A C, and on the end thereof, at C, raise the Perpendicular C E, equal to C A; then continue the side A B to E, and on the point B, with the Distance B A, or B E, describe the Semicircle A H E; and also on the point C, with the Distance C A, equal to C E, describe the Arch-line A O E, which two Lines will include the *Lunula* A O E H, equal to the given Square A B C D, as was required.



Again; Let the *Lunula* A O E H, be given to be reduced into a Square; First, draw the Line A E; then on the one half thereof, A B, or B E, make the Square A B C D, which will be equal to the *Lunula* A H O E, as was required.

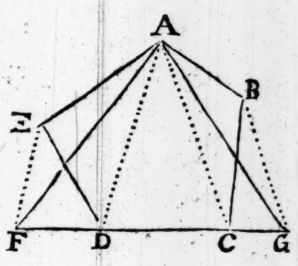
PRO-

PROBLEM XV.

To Reduce an Irregular Figure into a Triangle.

EXAMPLE.

Let A B C D E be the Figure of ſome Irregular Field, and it is required, from the Angle A, to reduce the ſame into a Triangle: Firſt, continue the Side D C of convenient Length both ways, towards F and G; then draw the Line E F, parallel to A D, till it interſect the extended Line C D in F, likewiſe draw the Line BG, parallel to A C, cutting the extended Line in G; then from the Angle A, draw the Lines A F, and A G: So ſhall you have the Triangle A F G, equal to the irregular Pentagon, A B C D E, which was required.

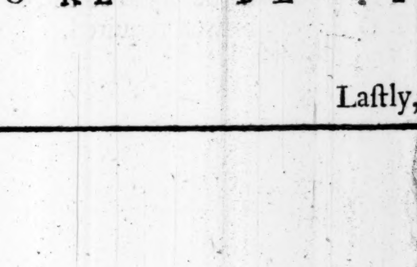


PROBLEM XVI.

To Reduce any Irregular-Multangled Figure into a Triangle.

EXAMPLE.

Suppoſe A B C D E F G, be an Irregular Figure or Plot, given to be reduced into a Triangle; firſt, draw the Line G E, and parallel thereto the Line F K; then from G, draw the Line G K; next, from B draw the Line B D, and parallel thereto the Line C L; then from B, extend the Line to L; ſo is the Plot of ſeven ſides reduced to five, namely, to the Figure A B L K G. Secondly, according to the laſt Problem, extend the Side K L, towards O and P; then draw the Line G O, parallel to A K, till it croſs the Line K L in O; alſo draw B P, parallel to the Line A L, till it croſs the extended Side K L in P:



Laſtly,

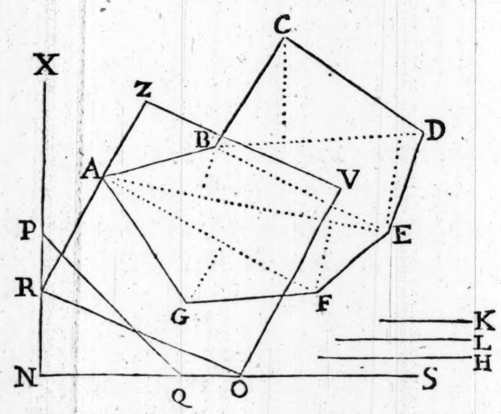
Laſtly, draw the Lines A O and A P; ſo ſhall you include the Triangle A O P, equal to the Irregular Heptagon A B C D E F G, as was required.

PROBLEM XVII.

To Reduce any Irregular Plot into a Geometrical-Square.

EXAMPLE.

Let A B C D E F G, be an Irregular Figure, given to be reduced into a Square; firſt, draw the Lines B E and A F; ſo will the Figure be divided into two Trapezia's, and one Triangle; then croſs the Trapezia's with the two Diagonals B D, and A E, and let fall the Perpendiculars from the Angles thereon, as from C, E, B, and F; and alſo from G, to the Baſe of the Triangle: Then, as is ſhewed in *Problem* X. of *Part* III. find a Mean-proportional Line, between half the Baſe B D, and the two Perpendiculars falling thereon, which is equal to the Line H:



In like manner, find a Mean-proportional Line between half the Baſe A E, and the two Perpendiculars thereon falling, which will in this Example be equal to the Line L; ſo alſo find out a Mean-proportional between half the Baſe of the Triangle A F, and its Perpendicular, which let be the Line K; which done, deſcribe a Right Angle at pleaſure, as X N S, wherein place the Line H, from N to P, and alſo the Line L, from N to Q, and draw the Line P Q; alſo place the Line K from N to R, then ſetting the Line P Q, from N to O, draw the Line R O, which is the Side of the Square required; and conſequently the Square R Z V O, will be equal to the aforegoing Irregular Figure A B C D E F G, as was required.

☞ I might have made a farther Progreſs in this part of Reduction; but in reſpect, in the Practice of Surveying, all (or moſt) Plots are produced in an irregular Form, in which I have ſufficiently ſupplied the Surveyor; it is therefore needleſs to enlarge further. Likewiſe I might have added, how to have performed Geometrically, the Rules of Addition, Subſtraction, Multiplication, and the Rule of Proportion; but ſince they are not eſſential to the Practical Surveyor, I ſhall not burden the Book with them: Neither have I omitted to alter and add any thing in this Geometrical Performance, that may be any way truly ſubſervient in the practical Part of Surveying: Thoſe therefore that would be further inform'd in this Geometrical Science, let them conſult *Euclid*, *Ramus*, *Pittiſcus*, or *de Chales*; which latter I chiefly recommend.

The End of the Fourth, and Laſt Part of Geometry.

THE

THE
Art of Surveying,
The THIRD BOOK.

Containing the Dimensions of all
Right-Angled TRIANGLES,
With the CANON of
Artificial Sines and Tangents,
to every Tenth Minute of the

QUADRANT.

Together with
A TABLE of *Logarithms* to 1000.
Being of Singular Use in the Solution of

TRIANGLES.

As it was formerly Published by the Author
VINCENT WING, Math.

LONDON,
Printed for *Awnsham* and *John Churchill*, at the *Black-Swan*,
in *Pater-Noster-Row*, MDCXCIX.

THE ART OF SURVEYING.

BOOK III.

Containing the Dimension of all Right Lined Triangles.

BECAUSE the Triangle (in respect of its Admirable Use in the *Mathematicks)* may justly challenge the Superiority of all Geometrical Figures; by the help whereof there is not any Question, or Problem *Geometrical*, or *Astronomical*, but m y thereby most exactly be resolved: It cannot therefore be unseasonable in this place, to insert all the Problems and Cases incident to Right-lined Triangles, and the rather, because the most of them are of extraordinary and common use for a Surveyor, in the taking of Heights and Distances, and in finding the Superficial Content, or Area of any Geometrical Figure, and more especially in the Dimension of all Regular Polygons, where their exact Superficial Capacities cannot otherwise be well obtained, as we shall have occasion afterwards to shew. And albeit I here intend not to speak of Spherical Triangles, as a thing without the Perimeter of an ordinary Surveyor's Use and Practice; yet I shall annex some Problems *Astronomical*, thereby performed, which will be necessary for him to understand; and for such as would be more fully satisfied in the Doctrine of *Trigonometry*, relating both to Right Lined Triangles and Spherical, I shall refer him to my *Astronomia Britannica*: But to my purpose:

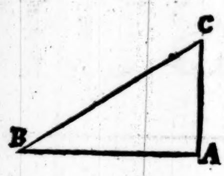
SECT. I.

Of the Dimension of Plain Rectangled Triangles.

PROBLEM I.

The Angles and one Leg being given, to find the other Leg.

IN the Rectangled Triangle ABC, the Side CA is inquired from



The given $\begin{cases}\text{Leg AB } 1123.7943 \\ \text{Angle ABC } gr\ 28.19'.48''.\end{cases}$

Terms of Proportion.

R : t. B :: BA : CA.

Illustration by Numbers.

As the Radius 90 Degrees	10.00000
To the Tangent of the Angle A B C *gr* 28.19'.48".	9.73168
So the Leg B A 1123.7943	3.05069
To the Leg C A 605.8601	2.78237

PROBLEM II.

The Hypothenuse *and Angles being given, to find either Leg.*

In the Rectangled Triangle BAC, the Side AB is inquired from

The given $\begin{cases}\textit{Hypothenuse}\text{ BC } 1276.7067 \\ \text{Angle ACB } gr\ 61.40'.12''.\end{cases}$

Terms of Proportion.

R : s. ACB :: BC : BA

Illustra-

Illustration by Numbers.

Radius 90 Degrees	10.00000
Sine of the Angle A C B *gr* 61. 40'. 12''.	9.94459
Hypothenuse B C 1276.7067	3.10609
Leg A B 1123.7943	305068

PROBLEM III.

The Angles and one Leg being given, to find the Hypothenuse.

In the Rectangled Triangle A B C, the *Hypothenuse* B C is inquired from

The given $\begin{cases}\text{Leg B A } 1123.7943 \\ \text{Angle B C A } gr\ 61.\ 40'.\ 12''.\end{cases}$

Terms of Proportion.

s. A C B : R :: B A : B C.

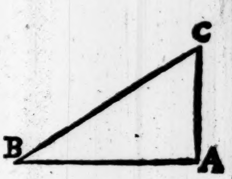
Illustration by Numbers.

As the Sine of the Angle A C B *gr* 61. 40'. 12''.	9.94459
To the Radius 90 Degrees	10.00000
So the given Leg A B 1123.7943.	3.05068
To the *Hypothenuse* B C 1276.7067	3.10609

PROBLEM IV.

The two Legs being given, to find either Angle.

In the Rectangled Triangle A B C, the Angle A B C is inquired from the



Legs given $\begin{cases}\text{B A } 1123.7943 \\ \text{C A } 605.8601\end{cases}$

Terms of Proportion.

B A : C A :: R : t. A B C.

As the Leg B A 1123.7943	3.05068
To the Leg C A 605.8601	2.78237
So the Radius 90 Degrees	10.00000
To the Tangent of the Angle A B C *gr* 28. 19'. 48''.	9.73169

PRO-

PROBLEM V.

The Hypothenuse *and a Leg being given, to find either Angle.*

In the Rectangled Triangle BAC, the Angle ACB is inquired from

The given $\begin{cases} \text{Leg} & AB\ 1123.7943 \\ \textit{Hypothenuse} & BC\ 1276.7067 \end{cases}$

Terms of Proportion.

BC : BA :: R : s. ACB

Illustration in Numbers.

As the *Hypothenuse* BC 1276.7067	3.10609
To the Leg BA 1123.7943	3.05068
So the Radius 90 Degrees	10.00000
To the Sine of the Angle ACB *gr.* 61. 40'. 12''.	9.94459

PROBLEM VI.

The Legs being given, to find the Hypothenuse.

In the Rectangled Triangle ABC, the *Hypothenuse* BC is required from the

Given Legs $\begin{cases} AB\ 1123.7943 \\ AC\ 605.8601 \end{cases}$

The Terms of Proportion.

1. BA : CA :: R : t. ABC.
2. s. ABC : R :: CA : BC.

Illustration by Numbers.

1. For the Angle ABC.

As the Leg AB 1123.7943	3.05068
To the Leg AC 605.8601	2.78237
So the Radius 90 Degrees	10.00000
To the Tangent of the Angle ABC *gr.* 28. 19'. 48''.	9.73169

2. For the *Hypothenuse* BC.

As the Sine of the Angle ABC *gr.* 28. 19'. 48''.	9.67628
To the Radius 90 Degrees	10.00000
So the Leg AC 605.8601	2.78237
To the *Hypothenuse* BC 1276.7067.	3.10609

PRO-

PROBLEM VII.

The Hypothenuse *and a Leg being given, to find the other Leg.*

In the Rectangled Triangle ABC, the Leg AC is inquired from

The given { *Hypothenuse* BC 1276.7067
 { Leg AB 1123.7943

Terms of Proportion.

1. BC : BA :: R : s. ACB.
2. R : s. ABC :: BC : AC.

Or it may be performed with more ease by one Operation.
Log. BA+BC *plus*; Log. BA–BC, Divis. *per* 2 =Log. CA.

Illustration by Numbers.

Hypothenuse BC	1276.7067	Sum	2400.5010.	3.38030
Leg BA	1123.7943	Difference	152.9124.	2.18444
			Aggregate	5.56474
Leg AC	605.8601		Semi-aggregate	2.78237

SECT. II.

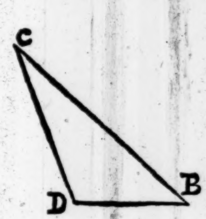
Of the Dimension of Plain Oblique-angled Triangles.

PROBLEM I.

Two Sides and an Angle opposite to one of them being given, to find the Angle opposite to the other Side.

IN the Oblique-angled Triangle BCD, the Angle B is inquired from

The given Sides { BC 1276.7067
 { CD 865.1765



Terms of Proportion.

BC : s. BDC :: CD : s. CBD

Illustra-

Illustration by Numbers.

As the Side B C 1276.7067	3.10609
To the Sine of the Angle BDC 116*d*. 12'. 22".	9.95289
So the Side C D 865.1765	2.93710
	12.88999
To the Sine of the Angle C B D 37*d*. 26'. 43".	9.78390

PROBLEM II.

Two Sides with the Angle included by them being given, to find either of the other Angles.

In the Oblique-angled Triangle B C D, either Angle at C or D is inquired, from the given

$$\text{Sides}\begin{cases}\text{BC } 1276.7067\\ \text{BD } 631.5525\end{cases}$$
Angle DBC 37 *d*. 26'. 43".

Terms of Proportion.

$$BD+CD : BD-CD :: t.\frac{C+B}{2} : t.\frac{X}{2}$$

$$\text{Then } \frac{C+B}{2} \begin{matrix}+\\-\end{matrix}\Big\} \frac{X}{2} = \text{Ang.}\begin{cases}BDC\\BCD\end{cases}$$

Illustration by Numbers.

As the Sum of the Sides B C and B D 1908.2592	3.28063
To their Difference 645.1542	2.80966
So the Tangent of half the Sum of the opposite Angles 71*d*. 16'. 38".	10.46989
	13.27956
To the Tangent of half the Difference 44*d*. 55'. 44".	9.99892

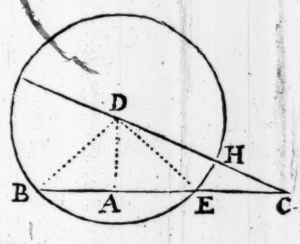
To the half Sum of the Angles	71*d*. 16'. 38".
Add the half Difference	44. 55. 44.
It giveth the Angle B D C	116. 12. 22.

From	71*d*. 16'. 38".
Substract	44. 55. 44.
The Angle BCD	26. 20. 54.

PRO-

PROBLEM III.

The three Sides being given, to find an Angle.



In the Oblique-angled Triangle BCD, either Angle is inquired.

Suppose the Angle DBC from

The given Sides	CB	1276.7067
	BD	631.5525
	CD	865.1765

Terms of Proportion.

1. BC : CD+BD :: CD−BD : CE
2. BD : R :: BA : cs. B.

Illustration in Numbers.

1.

As the greater Side BC 1276.7067	3.10609
To the Sum of CD and DB 1496.7290	3.17514
So the Difference HC 233.6240	2.36851
	5.54365
To the Differ. of the Segm. of the Base CE 273.8858,	2.43756
The Difference of this, and the Base BE	1002.8209
Whose half BA=EA	501.4104
Hence CA shall be	775.2962

2.

As the *Hypothenuse* BD 631.5525	2.80041
To the Leg BA 501.4104	2.70019
So the Radius 90 Degrees	10.00000
To the Sine of the Angle BDA 52 *d*. 33′. 16″	9.89978

Whose Complement ABD is 37*d*. 26′. 44″. The like course you are to take for the Angle ACD.

This Problem may more readily be resolved, and that at one Operation, by the following Precept; the Ground whereof is drawn from the Learned Mr. *Briggs* his *Arithmetica Logarithmica*, Cap. 10.

De dimidio collectorum laterum, latera sigillatim subducantur, &c. From half the Sum of the Sides, Substract the Sides one after another, and let the Sum of the Logarithms, of the half Sum of the Sides and Difference of the Sides subtending the Angle sought for, be substracted from the Sum of the Logarithms, of the other Differences, and the double Radius; the half of the Remainder, shall be the Logarithm of the Tangent of half the inquired Angle.

Let the Angle subtended by the greater side, be inquired, *viz.* BDC.

Illustration by Numbers.

The Side	BC	1276.7067	
	DC	865.1765	
	DB	631.5525	
The Sum of the Sides		2773.4357	
The half Sum		1386.7178	3.14199
The Difference of CB		110.0111	2.04143
		The Sum	5.18342 A
The Difference of the Side CD		521.5413	2.71729
The Difference of the Side BD		755.1653	2.87804
The Double Radius			20.00000
		The Sum	25.59533 B
		The Sum	5.18342 A
		The Difference	20.41191
		The half Difference	10.20595

is the Tangent of 58*d.* 6′. 11″. the Double whereof 116*d.* 12′.23″. is the Angle inquired BDC.

PROBLEM IV.

The Angles and a Side being given, to find either of the other Sides.

In the Oblique-angled Triangle BCD, the Side DC is inquired from the given

Angles	DBC	37*d.*	26.	43. ½	
	DCB	26.	20.	53. ½	
	BDC	116.	12.	23	

Side BC 1276.7067.

Terms of Proportion.

s. D : BC :: s. B : DC.

Illustration by Numbers.

As the Sine of the Angle FDC 63*d.* 47′,37″.	9.95289
To the Side FC, 1276.7067	3.10609
So the Sine of the Angle DBC 37*d.* 26′. 43″. ½	9.78393
	12.89000
To the Side DC 865.1795	2.9371.

PRO-

PROBLEM V.

Two Sides with the Angle included by them being given, to find the Third Side.

In the Oblique-angled Triangle BCD, the Side BC is inquired from

The given Sides $\begin{cases} DC\ 865.1765 \\ BD\ 631.5525 \end{cases}$

And the Angle BDC 116*d.* 12′. 23″.

First, Let the other Angles be inquired by the *Second Problem* of this *Section*, and the Angles being found, the Side inquired may be had by the last *Problem*. Examples are needless.

Advertisement.

WHEREAS *the following Tables of* Sines *and* Tangents *do extend only to every Tenth Minute of the* Quadrant, *and also the Table of* Logarithms *only to One Thousand; I thought good to give Notice to the* Reader, *That there is Printed a most Excellent and Useful Book for all Students in the* Mathematicks, *Intituled*, TRIGONOMETRIA BRITANNICA, *which contains the making of the Tables of* Sines Tangents, *and* Logarithms; *and also their Use in resolving of all* Triangles *either* Plain *or* Spherical: *In which Book you have the* Sines *and* Tangents *to every Degree, and Hundredth part of a Degree of the* Quadrant; *and the* Logarithms *of all Numbers, from One to an Hundred Thousand.*

Canon Triangulorum :

OR, A

TABLE

OF

Artificial Sines and Tangents,

To a Radius of 1000000. Parts, and every 10th Minute of the *Quadrant*.

Together with

A TABLE of Logarithms to

1000. Being of Singular Use in the Solution

OF

TRIANGLES.

Cuncta Trigonus habet satagit quæ docta Mathesis :
Ille aperit clausam quicquid Olympus habet.

A Table of Artificial Sines and Tangents.

Gr.M	Sin.	Cosin.	Tang.	Cotang.	M.Gr.
0 0	0.	10.00000	0.00000	Infinita.	0 90
10	7.46372	9.99999	7.46373	12.53627	50
20	7.76475	9.99999	7.76476	12.24524	40
30	7.94084	9.99998	7.94086	12.05914	30
40	8.06577	9.99997	8.06581	11.93419	20
50	8.16268	9.99995	8.16274	11.83726	10
1 0	8.24185	9.99993	8.24192	11.75808	0 89
10	8.30879	9.99991	8.30888	11.69112	50
20	8.36678	9.99988	8.36690	11.63310	40
30	8.41792	9.99985	8.41807	11.58193	30
40	8.46866	9.99981	8.46385	11.53615	20
50	8.50504	9.99978	8.50527	11.49473	10
2 0	8.54282	9.99973	8.54308	11.45692	0 88
10	8.97756	9.99969	8.57788	11.42212	50
20	8.60973	9.99964	8.61010	11.38990	40
30	8.63968	9.99958	8.64009	11.35991	30
40	8.66769	9.99953	8.66816	11.33184	20
50	8.69400	9.99947	8.69453	11.30547	10
3 0	8.71880	9.99940	8.71940	11.28060	0 87
10	8.74226	9.99933	8.74292	11.25708	50
20	8.76451	9.99926	8.76525	11.23475	40
30	8.78567	9.99919	8.78649	11.21351	30
40	8.80585	9.99911	8.80674	11.19326	20
50	8.82513	9.99903	8.82610	11.17390	10
4 0	8.84358	9.99894	8.84464	11.15536	0 86
10	8.86128	9.99885	8.86243	11.13757	50
20	8.87828	9.99876	8.87953	11.12047	40
30	8.89464	9.99866	8.89598	11.10402	30
40	8.91040	9.99856	8.91185	11.08815	20
50	8.92561	9.99845	8.92716	11.07284	10
5 0	8.94029	9.99834	8.94195	11.05805	0 85
10	8.95450	9.99823	8.95627	11.04373	50
20	8.96825	9.99810	8.97013	11.02987	40
30	8.98152	9.99800	8.98358	11.01642	30
40	8.99450	9.99787	8.99662	11.00338	20
50	9.00704	9.99773	9.00930	10.99070	10.
Gr.M	Cosin.	Sin.	Cotang.	Tang.	M.Gr.

A Table of Artificial Sines and Tangents.

Gr.M	Sin.	Cosin.	Tang.	Cotang.	M.Gr.
6 0	9.01923	9.99761	9.02162	10.97838	0 84
10	9.03109	9.99748	9.03361	10.96639	50
20	9.04262	9.99734	9.04528	10.95472	40
30	9.05386	9.99720	9.05666	10.94334	30
40	9.06480	9.99705	9.06775	10.93225	20
50	9.07548	9.99690	9.07858	10.92142	10
7 0	9.08589	9.99675	9.08914	10.91086	0 83
10	9.09606	9.99659	9.09947	10.90053	50
20	9.10599	9.99643	9.10956	10.89044	40
30	9.11570	9.99627	9.11943	10.88057	30
40	9.12519	9.99610	9.12909	10.87091	20
50	9.13447	9.99503	9.13854	10.86146	10
8 0	9.14355	9.99575	9.14780	10.852[illegible]0	0 82
10	9.15245	9.99557	9.15688	10.843[illegible]2	50
20	9.16116	9.99539	9.16577	10.834[illegible]3	40
30	9.16970	9.99520	9.17450	10.825[illegible]0	30
40	9.17807	9.99501	9.18306	10.816[illegible]4	20
50	9.18628	9.99482	9.19146	10.808[illegible]4	10
9 0	9.19433	9.99462	9.19971	10.80029	0 81
10	9.20223	9.99442	9.20782	10.79218	50
20	9.20999	9.99421	9.21578	10.78422	40
30	9.21761	9.99400	9.22361	10.77639	30
40	9.22509	9.99379	9.23130	10.76870	20
50	9.23244	9.99357	9.23887	10.76113	10
10 0	9.24967	9.99335	9.24632	10.75368	0 80
10	9.24679	9.99313	9.25365	10.74635	50
20	9.25376	9.99290	9.26086	10.73914	40
30	9.26063	9.99266	9.26797	10.73203	30
40	9.26739	9.99243	9.27496	10.72504	20
50	9.27405	9.99219	9.28186	10.71814	10
11 0	9.28060	9.99195	9.28865	10.71135	0 79
10	9.28705	9.99170	9.29535	10.70465	50
20	9.29340	9.99145	9.20195	10.69805	40
30	9.29965	9.99119	9.30846	10.69154	30
40	9.30582	9.99093	9.31488	10.68512	20
50	9.31190	9.99068	9.32122	10.67878	10 78
Gr.M	Cosin.	Tang.	Cotang.	Tang.	M.Gr.

A Table of Artificial Sines and Tangents.

Gr.M.	Sin.	Cosin.	Tang.	Cotang.	M.Gr.
12 0	9.31788	9.99040	9.32747	10.67253	0 78
10	9.32378	9.99013	9.33365	10.66635	50
20	9.32960	9.98986	9.33974	10.66026	40
30	9.33534	9.98958	9.34575	10.65424	30
40	9.34099	9.98930	9.35170	10.64830	20
50	9.34658	9.98901	9.35757	10.64243	10
13 0	9.35209	9.98872	9.36336	10.63664	0 77
10	9.35752	9.98843	9.36909	10.63091	50
20	9.36289	9.98813	9.37476	10.62524	40
30	9.36818	9.98783	9.38035	10.61965	30
40	9.37341	9.98752	9.38589	10.61411	20
50	9.37858	9.98722	9.39136	10.60864	10
14 0	9.38367	9.98690	9.39677	10.60323	0 76
10	9.38871	9.98659	9.40212	10.59788	50
20	9.39368	9.98627	9.40742	10.59258	40
30	9.39860	9.98594	9.41266	10.58734	30
40	9.40345	9.98561	9.41784	10.58216	20
50	9.40825	9.98528	9.42297	10.57703	10
15 0	9.41229	9.98494	9.42895	10.57195	0 75
10	9.41768	9.98460	9.43308	10.56692	50
20	9.42232	9.98426	9.44046	10.56194	40
30	9.42690	9.98391	9.44299	10.55701	30
40	9.43143	9.98356	9.44787	10.55213	20
50	9.43592	9.98320	9.45271	10.54720	10
16 0	9.44034	9.98284	9.45750	10.54250	0 74
10	9.44472	9.98248	9.46224	10.53776	50
20	9.44905	9.98211	9.46694	10.53305	40
30	9.45334	9.98174	9.47160	10.52839	30
40	9.45758	9.98136	9.47622	10.52378	20
50	9.46178	9.98098	9.48080	10.51920	10
17 0	9.46593	9.98060	9.48534	10.51466	0 73
10	9.46944	9.98021	9.48984	10.51016	50
20	9.47411	9.97982	9.49430	10.50570	40
30	9.47814	9.97942	9.49872	10.50128	30
40	9.48213	9.97902	9.50311	10.49689	20
50	9.48607	9.97861	9.50746	10.49254	10 72
Gr.M	Cosin.	Sin.	Cotang.	Tang.	M.Gr.

A Table of Artificial Sines and Tangents.

Gr.M	Sin.	Cosin.	Tang.	Cotang.	M.Gr.
18 0	9.48998	9.97821	9.51178	10.48822	0 72
10	9.49385	9.97779	9.51606	10.48394	50
20	9.49768	9.97738	9.52030	10.47969	40
30	9.50147	9.97796	9.52452	10.47548	30
40	9.50523	9.97653	9.52870	10.47130	20
50	9.50895	9.97610	9.53285	10.4671	10
19 0	9.51264	9.97567	9.53697	10.46303	0 71
10	9.51629	9.97528	9.54106	10.4589	50
20	9.51991	9.97479	9.54512	10.4548	40
30	9.52349	9.97434	9.54915	10.4508	30
40	9.52704	9.97390	9.55315	10.44685	20
50	9.53056	9.97344	9.75712	10.44288	10
20 0	9.53405	9.97299	9.56107	10.43893	0 70
10	9.53751	9.97252	9.56498	10.43502	50
20	9.54093	9.97286	9.56887	10.43113	40
30	9.54432	9.97159	9.57274	10.42726	30
40	9.54799	9.97111	9.57658	10.42352	20
50	9.55102	9.97063	9.58039	10.41961	10
21 0	9.55433	9.97015	9.58418	10.41582	0 69
10	9.55761	9.96966	9.58794	10.41206	50
20	9.56085	9.96917	9.59168	10.40832	40
30	9.56407	9.96868	9.59540	10.40460	30
40	9.56727	9.96818	9.59909	10.40091	20
50	9.57043	9.96767	9.60276	10.39724	10
22 0	9.57357	9.96716	9.60641	10.39359	0 68
10	9.57669	9.96665	9.61004	10.38996	50
20	9.57978	9.96613	9.61364	10.38636	40
30	9.58284	9.96561	9.61722	10.38278	30
40	9.58588	9.96509	9.62079	10.37921	20
50	9.58889	9.96456	9.62433	10.37567	10
23 0	9.59188	9.96402	9.62785	10.37215	0 67
10	9.59484	9.96349	9.63135	10.36865	50
20	9.59778	9.96294	9.63484	10.36516	40
30	9.60070	9.96240	9.63830	10.36170	30
40	9.60359	9.96184	9.64175	10.35825	20
50	9.60446	9.96129	9.64517	10.35483	10.
Gr.M	Cosin.	Sin.	Cotang.	Tang.	M.Gr.

A Table of Artificial Sines and Tangents.

Gr.M	Sin.	Cosin.	Tang.	Cotang.	M.Gr.
24 0	9.60991	9.96073	9.64858	10.35142	0 66
10	9.61215	9.96017	9.65197	10.34803	50
20	9.61494	9.95960	9.65535	10.34465	40
30	9.61773	9.95902	9.65870	10.34130	30
40	9.62049	9.95844	9.66204	10.33796	20
50	9.62323	9.95786	9.66537	10.33463	10
25 0	9.62595	9.95728	9.66867	10.33133	0 65
10	9.62865	9.95668	9.67196	10.32804	50
20	9.63133	9.95609	9.67524	10.32476	40
30	9.63398	9.95549	9.67859	10.32150	30
40	9.63662	9.95488	9.68174	10.31826	20
50	9.63924	9.95427	9.68497	10.31503	10
26 0	9.64184	9.95366	9.68818	10.31182	0 64
10	9.64442	9.95304	9.69138	10.30862	50
20	9.64698	9.95242	9.69457	10.30543	40
30	9.64953	9.95179	9.69774	10.30226	30
40	9.65205	9.95116	9.70289	10.29911	20
50	9.65456	9.95052	9.70404	10.29596	10
27 0	9.65705	9.94988	9.70717	10.29283	0 63
10	9.65952	9.94923	9.71028	10.28972	50
20	9.66197	9.94858	9.71339	10.28671	40
30	9.66441	9.94793	9.71648	10.28352	30
40	9.66682	9.94727	9.71956	10.28944	20
50	9.66922	9.94660	9.72262	10.27738	10
28 0	9.67161	9.94593	9.72567	10.27433	0 62
10	9.67393	9.94526	9.72872	10.27128	50
20	9.67633	9.94458	9.73175	10.26825	40
30	9.67866	9.94360	9.73476	10.26524	30
40	9.68098	9.94321	9.73777	10.26223	20
50	9.68328	9.94252	9.74077	10.25623	10
29 0	9.68557	9.94182	9.74375	10.25625	0 61
10	9.68784	9.94112	9.74673	10.25327	50
20	9.69010	9.94041	9.74969	10.25031	40
30	9.69234	9.93970	9.75264	10.24736	30
40	9.69456	9.93898	9.75558	10.24442	20
50	9.69677	9.93826	9.75852	10.24448	10.
Gr.M	Cosin.	Sin.	Cotang.	Tang.	M.Gr.

A Table of Artificial Sines and Tangents.

Gr.M	Sin.	Cosin.	Tang.	Cotang.	M.Gr
30 0	9.69897	9.93753	9.76144	10.23855	0 60
10	9.07115	9.93680	9.76435	10.23565	50
20	9.07332	9.93606	9.76726	10.23278	40
30	9.70547	9.93532	9.77015	10.28985	30
40	9.70760	9.93457	9.77303	10.22697	20
50	9.70973	9.93382	9.77591	10.22409	10
31 0	9.71184	9.93307	9.77877	10.22123	0 59
10	9.71393	9.93230	9.78163	10.21837	50
20	9.71601	9.93154	9.78448	10.21552	40
30	9.71808	9.93077	9.78732	10.21268	30
40	9.72014	9.92999	9.79015	10.20985	20
50	9.72218	9.92921	9.79297	10.20703	10
32 0	9.72421	9.92842	9.79579	10.20421	0 58
10	9.72622	9.92763	9.79860	10.20140	50
20	9.72823	9.92683	9.80140	10.19860	40
30	9.73022	9.92603	9.80419	10.19581	30
40	9.73219	9.92522	9.80697	10.19303	20
50	9.73417	9.92441	9.80975	10.19025	10
33 0	9.73611	9.92359	9.81252	10.18748	0 57
10	9.73805	9.92277	9.81528	10.18412	50
20	9.73997	9.92194	9.81803	10.18196	40
30	9.74189	9.92111	9.82078	10.17922	30
40	9.74379	9.92027	9.82352	10.17648	20
50	9.74568	9.91942	9.82626	10.17374	10
34 0	9.74756	9.91857	9.82899	10.17104	0 56
10	9.74943	9.91772	9.83171	10.16829	50
20	9.75128	9.91686	9.83442	10.16558	40
30	9.75313	9.91599	9.83713	10.16287	30
40	9.75496	6.91512	9.83984	10.16016	20
50	9.75678	9.91425	9.84253	10.15747	10
35 0	9.75859	9.91336	9.84523	10.15477	0 55
10	9.76039	9.91248	9.84791	10.15209	50
20	9.76218	9.91158	9.85059	10.14941	40
30	9.76395	9.91069	9.85327	10.14673	30
40	9.76572	9.90978	9.85594	10.14405	20
50	9.76747	9.90887	9.85860	10.14140	10.
Gr.M	Cosin.	Sin.	Cotang.	Tang.	M.Gr.

A Table of Artificial Sines and Tangents.

Gr.M	Sin.	Cosin.	Tang.	Cotang.	M.Gr.
36 0	9.76922	9.90796	9.86126	10.13874	0 54
10	9.77095	9.90704	9.86391	10.13609	50
20	9.77267	9.90611	9.86656	10.13344	40
30	9.77439	9.90518	9.86921	10.13079	30
40	9.77609	9.90424	9.87185	10.12815	20
50	9.77778	9.90330	9.87448	10.12552	10
37 0	9.77946	9.90235	9.87711	10.12289	0 53
10	9.78113	9.90139	9.87974	10.12026	50
20	9.78280	9.90043	9.88236	10.11764	40
30	9.78445	9.89947	9.88498	10.11502	30
40	9.78690	9.89849	9.88759	10.11241	20
50	9.78772	9.89152	9.89020	10.10980	10
38 0	9.78934	9.89653	9.89281	10.10719	0 52
10	9.79095	9.89554	9.89541	10.10459	50
20	9.79256	9.89455	9.89801	10.10199	40
30	9.79415	9.89354	9.90060	10.09939	30
40	9.79573	9.89254	9.90320	10.09680	20
50	9.79731	9.89152	9.90578	10.09422	10
39 0	9.79887	9.89050	9.90837	10.09163	0 51
10	9.80043	9.88948	9.91095	10.08905	50
20	9.80197	9.88844	9.91353	10.08647	40
30	9.80351	9.88741	9.91610	10.08390	30
40	9.80504	9.88636	9.91868	10.08132	20
50	9.80656	9.88531	9.92125	10.07875	10
40 0	9.80807	9.88425	9.92381	10.07619	0 50
10	9.80957	9.88319	9.92638	10.07362	50
20	9.81006	9.88212	9.92894	10.07106	40
30	9.81254	9.88104	9.93150	10.06850	30
40	9.81402	9.87996	9.93406	10.06594	20
50	9.81548	9.87887	9.93661	10.06339	10
41 0	9.81694	9.87778	9.93916	10.06081	0 49
10	9.81839	9.87608	9.94171	10.05829	50
20	9.81983	9.87557	9.94426	10.05574	40
30	9.82126	9.87446	9.94681	10.05319	30
40	9.82269	9.87333	9.94935	10.05065	20
50	9.82410	9.87221	9.95190	10.04810	10.48
Gr.M	Cosin.	Tang.	Cotang.	Tang.	M.Gr.

A Table of Artificial Sines and Tangents.

Gr. M	Sin.	Cosin.	Tang.	Cotang.	M. Gr.
42 0	9.82551	9.87107	9.95444	10.04556	0 48
10	9.82691	9.86993	9.95698	10.04302	50
20	9.82830	9.86878	9.95952	10.04048	40
30	9.82968	9.86763	9.96205	10.03795	30
40	9.83106	9.86647	9.96459	10.03541	20
50	9.83242	9.86530	9.96712	10.03288	10
43 0	9.83378	9.86413	9.96966	10.03034	0 47
10	9.83513	9.86294	9.97219	10.02781	50
20	9.83648	9.86176	9.97472	10.02528	40
30	9.83781	9.86056	9.97725	10.02275	30
40	9.83914	9.85936	9.97978	10.02022	20
50	9.84046	9.85815	9.98231	10.01769	10
44 0	9.84177	9.85693	9.98484	10.01516	0 46
10	9.84308	9.85571	9.98736	10.01264	50
20	9.84437	9.85448	9.98989	10.01011	40
30	9.84566	9.85324	9.99242	10.00758	30
40	9.84694	9.85200	9.99405	10.00505	20
50	9.84822	9.85074	9.99747	10.00253	10
45 0	9.84948	9.84948	10.00000	10.00000	0 45
Gr. M	Cosin.	Sin.	Cotang.	Tang.	M. Gr.

Explanation of the Table by Example.

1. SUppose it be required to find the Sine and Tangent of 30. degr. 20. min. therefore I seek the same in the first Column on the left hand under Gr. 1. and find the Sine thereof 9.70332. and the Tangent 9.76726. its Cosine 9.93606, and the Cotangent 10.23278.

2. But suppose 9.73997. be a Sine given, and the Arch thereof is required; therefore I seek in the second Column amongst the Sines for 9.73997. and against it on the left hand, I find 33. degr. 20. min. which is the Arch answering thereunto.

But if you find not your just number, then take the nearest in the Table; which you shall find exact enough for Instrumental Observations.

A Table

A Table of Logarithms.

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
0	0,00000	44	1,64345	88	1,94448	132	2,12057
1	0,00000	45	1,65321	89	1,94939	133	2,12385
2	0,30103	46	1,66276	90	1,95424	134	2,12710
3	0,47713	47	1,67210	91	1,95904	135	2,13033
4	0,60206	48	1,68124	92	1,96379	136	2,13354
5	0,69897	49	1,69020	93	1,96848	137	2,13672
6	0,77815	50	1,69897	94	1,97313	138	2,13988
7	0,84510	51	1,70757	95	1,97972	139	2,14301
8	0,90309	52	1,71600	96	1,98117	140	2,14613
9	0,95424	53	1,72427	97	1,98677	141	2,14922
10	1,00000	54	1,73239	98	1,99123	142	2,15229
11	1,04139	55	1,74036	99	1,99563	143	2,15534
12	1,07918	56	1,74819	100	2,00000	144	2,18836
13	1,11394	57	1,75587	101	2,00432	145	2,16137
14	1,14613	58	1,76343	102	2,00860	146	2,16435
15	1,17609	59	1,77085	103	2,01284	147	2,16732
16	1,20412	60	1,77815	104	2,01703	148	2,17026
17	1,23045	61	1,78533	105	2,02119	149	2,17319
18	1,25527	62	1,79219	106	2,02530	150	2,17609
19	1,27875	63	1,79934	107	2,02938	151	2,17898
20	1,30103	64	1,80648	108	2,03342	152	2,18184
21	1,32222	65	1,81291	109	2,03743	153	2,18469
22	1,34242	66	1,81954	110	2,04139	154	2,18752
23	1,36173	67	1,82607	111	2,04532	155	2,19033
24	1,38021	68	1,83251	112	2,04922	156	2,19312
25	1,39794	69	1,83885	113	2,05308	157	2,19590
26	1,41497	70	1,84510	114	2,05690	158	2,19866
27	1,43136	71	1,85126	115	2,06070	159	2,20140
28	1,44716	72	1,85733	116	2,06446	160	2,20412
29	1,46240	73	1,86332	117	2,06819	161	2,20683
30	1,47712	74	1,86923	118	2,07188	162	2,20951
31	1,49136	75	1,87506	119	2,07555	163	2,21219
32	1,50515	76	1,88081	120	2,07918	164	2,21484
33	1,51851	77	1,88649	121	2,08278	165	2,21748
34	1,53148	78	1,89209	122	2,08636	166	2,22011
35	1,54407	79	1,89763	123	2,08990	167	2,22272
36	1,55630	80	1,90309	124	2,09342	168	2,22531
37	1,56820	81	1,90848	125	2,09691	169	2,22789
38	1,57978	82	1,91381	126	2,10037	170	2,23045
39	1,59106	83	1,91908	127	2,10380	171	2,23300
40	1,60206	84	1,92428	128	2,10721	172	2,23553
41	1,61278	85	1,92942	129	2,11059	173	2,23805
42	1,62325	86	1,93450	130	2,11394	174	2,24055
43	1,63347	87	1,93952	131	2,11727	175	2,24304

A Table of Logarithms.

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
176	2,24551	220	2,34243	264	2,42160	308	2,48855
177	2,24797	221	2,34439	265	2,42325	309	2,48996
178	2,25042	222	2,34635	266	2,42488	310	2,49136
179	2,25285	223	2,34830	267	2,42651	311	2,49276
180	2,25527	224	2,35025	268	2,42813	312	2,49415
181	2,25768	225	2,35218	269	2,42975	313	2,49554
182	2,26007	226	2,35411	270	2,43136	314	2,49693
183	2,26225	227	2,35603	271	2,43297	315	2,49831
184	2,26482	228	2,35793	272	2,43457	316	2,49969
185	2,26717	229	2,35983	273	2,43616	317	2,50106
186	2,26951	230	2,36173	274	2,43775	318	2,50243
187	2,27184	231	2,36361	275	2,43933	319	2,50379
188	2,27416	232	2,36549	276	2,44091	320	2,50515
189	2,27646	233	2,36736	277	2,44248	321	2,50650
190	2,27875	234	2,36922	278	2,44404	322	2,50786
191	2,28108	235	2,37107	279	2,44560	323	2,50920
192	2,28330	236	2,37291	280	2,44716	324	2,51054
193	2,28556	237	2,37475	281	2,44871	325	2,51188
194	2,28780	238	2,37658	282	2,45025	326	2,51322
195	2,29002	239	2,37840	283	2,45179	327	2,51455
196	2,29226	240	2,38021	284	2,45332	328	2,51587
197	2,29447	241	2,38202	285	2,45484	329	2,51720
198	2,29666	242	2,38381	286	2,45636	330	2,51851
199	2,29885	243	2,38561	287	2,45789	331	2,51983
200	2,30103	244	2,38739	288	2,45939	332	2,52114
201	2,30340	245	2,38917	289	2,46090	333	2,52244
202	2,30535	246	2,39093	290	2,46240	334	2,52375
203	2,30750	247	2,39270	291	2,46387	335	2,52504
204	2,30963	248	2,39445	292	2,46538	336	2,52634
205	2,31175	249	2,39620	293	2,46687	337	2,52763
206	2,31387	250	2,39794	294	2,46835	338	2,52892
207	2,31597	251	2,39967	295	2,46982	339	2,53020
208	2,31806	252	2,40140	296	2,47129	340	2,53148
209	2,32015	253	2,40312	297	2,47276	341	2,53275
210	2,32222	254	2,40483	298	2,47422	342	2,53403
211	2,32428	255	2,40654	299	2,47567	343	2,53529
212	2,32634	256	2,40824	300	2,47712	344	2,53656
213	2,32838	257	2,40993	301	2,47856	345	2,53782
214	2,33041	258	2,41162	302	2,48001	346	2,53908
215	2,33244	259	2,41320	303	2,48144	347	2,54033
216	2,33443	260	2,41497	304	2,48287	348	2,54158
217	2,33646	261	2,41664	305	2,48430	349	2,54283
218	2,33846	262	2,41830	306	2,48572	350	2,54407
219	2,34044	263	2,41996	307	2,48714	351	2,54531

A Table of Logarithms.

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
352	2,54654	396	2,57769	440	2,64345	484	2,68484
353	2,54777	397	2,59879	441	2,64444	485	2,68574
354	2,54900	398	2,59988	442	2,64542	486	2,68664
355	2,55023	399	2,60097	443	2,64640	487	2,68753
356	2,55145	400	2,60206	444	2,64738	488	2,68842
357	2,55267	401	2,60314	445	2,64836	489	2,68931
358	2,55388	402	2,60423	446	2,64933	490	2,69020
359	2,55509	403	2,60530	447	2,65031	491	2,69108
360	2,55630	404	2,60638	448	2,65128	492	2,69196
361	2,55751	405	2,60745	449	2,65225	493	2,69285
362	2,55871	406	2,60853	450	2,65321	494	2,69373
363	2,55991	407	2,60959	451	2,65418	495	2,69460
364	2,56110	408	2,61066	452	2,65514	496	2,69548
365	2,56229	409	2,61172	453	2,65610	497	2,69636
366	2,56348	410	2,61278	454	2,65706	498	2,69723
367	2,56467	411	2,61384	455	2,65801	499	2,69810
368	2,56585	412	2,61490	456	2,65996	500	2,69897
369	2,56703	413	2,61595	457	2,65991	501	2,69984
370	2,56820	414	2,61700	458	2,66086	502	2,70070
371	2,56937	415	2,61805	459	2,66181	503	2,70157
372	2,57054	416	2,61909	460	2,66276	504	2,70243
573	2,57171	417	2,62014	461	2,66370	505	2,70329
374	2,57287	418	2,62118	462	2,66464	506	2,70415
375	2,57403	419	2,62221	463	2,66558	507	2,70501
376	2,57519	420	2,62325	464	2,66652	508	2,70586
377	2,57634	421	2,62428	465	2,66745	509	2,70672
378	2,57749	422	2,62531	466	2,66838	510	2,70757
379	2,57864	423	2,62634	467	2,66932	511	2,70842
380	2,57978	424	2,62737	468	2,67024	512	2,70927
381	2,58092	425	2,62839	469	2,67117	513	2,71012
382	2,58206	426	2,62941	470	2,67210	514	2,71096
383	2,58320	427	2,63043	471	2,67302	515	2,71181
384	2,58433	428	2,63144	472	2,67394	516	2,71265
385	2,58546	429	2,63246	473	2,67486	517	2,71349
386	2,58659	430	2,63347	474	2,67578	518	2,71433
387	2,58771	431	2,63448	475	2,67669	519	2,71517
388	2,58883	432	2,63548	476	2,67761	520	2,71600
389	2,58995	433	2,63649	477	2,67852	521	2,71684
390	2,59106	434	2,63749	478	2,67943	522	2,71767
391	2,59218	435	2,63849	479	2,68033	523	2,71850
392	2,59329	436	2,63949	480	2,68124	524	2,71933
393	2,59439	437	2,64048	481	2,68214	525	2,72016
394	2,59549	438	2,64147	482	2,68305	526	2,72099
395	2,59660	439	2,64246	483	2,68395	527	2,72181

A Table of Logarithms.

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
527	2,72181	571	2,75664	615	2,78887	659	2,81838
528	2,72263	572	2,75740	616	2,78958	660	2,81954
529	2,72346	573	2,75815	617	2,79028	661	2,82020
530	2,72345	574	2,75891	618	2,79099	662	2,82086
531	2,72509	575	2,75967	619	2,79169	663	2,82151
532	2,72591	576	2,76042	620	2,79239	664	2,82217
533	2,72673	577	2,76118	621	2,79309	665	2,82282
534	2,72754	578	2,76193	622	2,79379	666	2,82347
535	2,72835	579	2,76268	623	2,79449	667	2,82413
536	2,72916	580	2,76343	624	2,79518	668	2,82478
537	2,72997	581	2,76418	625	2,79588	669	2,82543
538	2,73078	582	2,76492	626	2,79657	670	2,82607
539	2,73159	583	2,76567	627	2,79727	671	2,82672
540	2,73239	584	2,76641	628	2,79796	672	2,82737
541	2,73320	585	2,76716	629	2,79865	673	2,82801
542	2,73400	586	2,76790	630	2,89934	674	2,82866
543	2,73480	587	2,76864	631	2,80003	675	2,82930
544	2,73560	588	2,76938	632	2,80072	676	2,82995
545	2,73640	589	2,77011	633	2,80140	677	2,83059
546	2,73719	590	2,77085	634	2,80208	678	2,83123
547	2,73799	591	2,77159	635	2,80277	679	2,83187
548	2,73878	592	2,77232	636	2,80346	680	2,83251
549	2,73957	593	2,77305	637	2,80414	681	2,83315
550	2,74036	594	2,77379	638	2,80482	682	2,83378
551	2,74115	595	2,77452	639	2,80550	683	2,83442
552	2,74191	596	2,77525	640	2,80618	684	2,83506
553	2,74272	597	2,77597	641	2,80656	685	2,83569
554	2,74351	598	2,77670	642	2,80753	686	2,83632
555	2,74429	599	2,77743	643	2,80821	687	2,83696
556	2,74507	600	2,77815	644	2,80889	688	2,83759
557	2,74585	601	2,77887	645	2,80956	689	2,83822
558	2,74663	602	2,77960	646	2,81023	690	2,83885
559	2,74741	603	2,78032	647	2,81090	691	2,83948
560	2,74819	604	2,78104	648	2,81157	692	2,84011
561	2,74896	605	2,78175	649	2,81224	693	2,84073
562	2,74973	606	2,78247	650	2,81291	694	2,84136
563	2,75051	607	2,78319	651	2,81358	695	2,84198
564	2,75128	608	2,78390	652	2,81425	696	2,84261
565	2,75205	609	2,78462	653	2,81491	697	2,84323
566	2,75282	610	2,78533	654	2,81558	698	2,84385
567	2,75358	611	2,78604	655	2,81624	699	2,84448
568	2,75435	612	2,78675	656	2,81690	700	2,84510
569	2,75511	613	2,78746	657	2,81756	701	2,84572
570	2,75587	614	2,78816	658	2,81822	702	2,84634

A Table of Logarithms.

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
703	2,84695	747	2,87332	791	2,89818	835	2,92169
704	2,84757	748	2,87390	792	2,89872	836	2,92221
705	2,84819	749	2,87448	793	2,89927	837	2,92272
706	2,84880	750	2,87506	794	2,89982	838	2,92324
707	2,84942	751	2,87564	795	2,90037	839	2,92376
708	2,85001	752	2,87622	796	2,90091	840	2,92428
709	2,85065	753	2,87679	797	2,90146	841	2,92480
710	2,85126	754	2,87737	798	2,90200	842	2,92531
711	2,85187	755	2,87795	799	2,90215	843	2,92582
712	2,85248	756	2,87852	800	2,90309	844	2,92634
713	2,85309	757	2,87910	801	2,90363	845	2,92686
714	2,85370	758	2,87967	802	2,90417	846	2,92737
715	2,85431	759	2,88024	803	2,90472	847	2,92788
716	2,85491	760	2,88081	804	2,90526	848	2,92840
717	2,85552	761	2,88138	805	2,90580	849	2,92891
718	2,85612	762	2,88195	806	2,90633	850	2,92942
719	2,85673	763	2,88252	807	2,90687	851	2,92993
720	2,85733	764	2,88309	808	2,90741	852	2,93044
721	2,85793	765	2,88361	809	2,90795	853	2,93095
722	2,85854	766	2,88423	810	2,90848	854	2,93146
723	2,85914	767	2,88479	811	2,90902	855	2,93197
724	2,85974	768	2,88536	812	2,90956	856	2,93247
725	2,86034	769	2,88592	813	2,91005	857	2,93298
726	2,86094	770	2,88649	814	2,91062	858	2,93349
727	2,86153	771	2,88705	815	2,91116	859	2,93399
728	2,86213	772	2,88762	816	2,91169	860	2,93450
729	2,86273	773	2,88818	817	2,91222	861	2,93500
730	2,86332	774	2,88874	818	2,91277	862	2,93551
731	2,86392	775	2,88930	819	2,91328	863	2,93601
732	2,86451	776	2,88986	820	2,91381	864	2,93651
733	2,86510	777	2,89042	821	2,91434	865	2,93701
734	2,86570	778	2,89093	822	2,91487	866	2,93752
735	2,86629	779	2,89154	823	2,91540	867	2,93802
736	2,86688	780	2,89209	824	2,91593	868	2,93852
737	2,86747	781	2,89265	825	2,91645	869	2,93902
738	2,86806	782	2,89321	826	2,91698	870	2,93952
739	2,86864	783	2,89376	827	2,91751	871	2,94002
740	2,86923	784	2,89431	828	2,91803	872	2,94052
741	2,86982	785	2,89487	829	2,91855	873	2,94102
742	2,87040	786	2,89542	830	2,91908	874	2,94151
743	2,87099	787	2,89597	831	2,91960	875	2,94201
744	2,87157	788	2,89653	832	2,92012	876	2,94250
745	2,87216	789	2,89708	833	2,92064	877	2,94300
746	2,87274	790	2,89763	834	2,92117	878	2,94349

A Table of Logarithms.

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
877	2,94300	908	2,95809	939	2,97267	970	2,98677
878	2,94349	909	2,95856	940	2,97313	971	2,98722
879	2,94399	910	2,95904	941	2,97359	972	2,98767
880	2,94448	911	2,95952	942	2,97405	973	2,98811
881	2,94498	912	2,95999	943	2,97451	974	2,98856
882	2,94547	913	2,96047	944	2,97497	975	2,98900
883	2,94596	914	2,96095	945	2,97543	976	2,98945
884	2,94645	915	2,96142	946	2,97589	977	2,98989
885	2,94694	916	2,96189	947	2,97635	978	2,99034
886	2,94743	917	2,96237	948	2,97681	979	2,99078
887	2,94792	918	2,96284	949	2,97727	980	2,99113
888	2,94841	919	2,96331	950	2,97772	981	2,99167
889	2,94890	920	2,96379	951	2,97818	982	2,99211
890	2,94939	921	2,96426	952	2,97864	983	2,99255
891	2,94988	922	2,96473	953	2,97909	984	2,99299
892	2,95036	923	2,96520	954	2,97955	985	2,99344
893	2,95085	924	2,96567	955	2,98000	986	2,99388
894	2,95134	925	2,96614	656	2,98046	987	2,99432
895	2,95182	926	2,96661	957	2,98091	988	2,99476
896	2,95231	927	2,96708	958	2,98137	989	2,99520
897	2,95279	928	2,96755	959	2,98182	990	2,99563
898	2,95328	929	2,96802	960	2,98227	991	2,99607
899	2,95376	930	2,96848	961	2,98272	992	2,99651
900	2,95424	931	2,96895	962	2,98317	993	2,99695
901	2,95472	932	2,96941	963	2,98363	994	2,99739
902	2,95521	933	2,96988	964	2,98408	995	2,99782
903	2,95569	934	2,97035	965	2,98453	996	2,99826
904	2,95617	935	2,97081	966	2,98498	997	2,99869
905	2,95664	936	2,97128	967	2,98543	998	2,99913
906	2,95713	937	2,97174	968	2,98587	999	2,99956
907	2,95761	938	2,97220	969	2.98632	1000	3,00000

An Explanation of the former TABLE *of* Logarithms.

EVERY *Page* in the former *Table of Logarithms*, is divided into eight Columns, or Spaces; whereof the first, third, fifth, and seventh, having the Letter N. at the Head thereof, are the Numbers successively continued from 1. to 1000. So that to find the *Logarithm* of any Number under 1000, you must find the Number given; and against the same, towards the Right Hand, you have the Logarithm thereof.

EXAMPLE.

Suppose the Number given be 720, and its Logarithm is required; therefore in the third Row, under the Title N, I seek the said Number, and against the same stands 2,85733, which is the Logarithm desired.

But if a Logarithm be given, and the absolute Number thereto belonging is required; then seek out the Logarithm under the Title, and against the same towards the Left Hand, is the absolute Number answering to that Logarithm.

If you cannot find in the Table the just Logarithm you seek for, you must take the nearest thereunto; or in the Table of Sines and Tangents, you may (if you please) make proportion; so shall you take the Logarithm to a Minute: but in such cases your own Judgment may best inform you.

The End of the Third Book.

THE

THE
Art of Surveying,
The FOURTH BOOK.

Wherein is ſhewed,

How to take the Exact PLOT
of all Manner of GROUNDS whatſoever,
after Several Ways:

BY THE

PLAIN TABLE.

AND

How to Caſt up the Juſt Quantity, and Content
thereof, in *Acres*, *Roods*, and *Perches*.

And alſo, How to Incloſe, and Take in a

LORDSHIP,

That lieth in Common, or in Open Fields,
And to Draw a Perfect Map thereof.

AND ALSO

How *Statute-Meaſure*, may be Reduced to *Cuſtomary-Meaſure*; and the Contrary.

As it was formerly Publiſhed by the Author
VINCENT WING, Math.

LONDON,
Printed for *Awnſham* and *John Churchill*, at the *Black-Swan*,
in *Pater-Noſter-Row*, MDCXCIX.

THE ART OF SURVEYING.

BOOK IV.

The PROEM.

THIS *was the* Sixth Book, *which is now made the* Fourth, *being the Essential part of the whole* Book, *as my Uncle, Mr.* Vincent Wing, *Printed it, for the* Practical part *of* Surveying; *and has gained the Approbation of most of the Ablest Surveyors of this Nation: I have therefore only taken out his* Twentieth Chapter, *and added it with Additions in the* Second Book; viz. *in the Third Part of the* Book of Geometry, *being the* Ninth Problem; *being (as I conceive) in a more convenient place for that purpose. And what is deficient, or wanting in this* Fourth Book, *I have largely supplied in my* Appendix *hereunto adjoyned; to which I refer the Ingenious Surveyor for further Satisfaction.*

CHAP.

CHAP. I.

A Description of the Plain Table, *with its several Parts, and Composition,* &c.

AMONGST the manifold Instruments which have hitherto been invented, for the Exact and Speedy Plotting and Measuring of all kinds of Land, there is none so plain and perspicuous in Use and Practice, as this Instrument, and therefore it aptly receiveth the Name and Appellation of the *Plain-Table:* And albeit this Instrument (as well as any other) may be slighted and abused by the Ignorance of the Common Mechanicks, and other Illiterate Pretenders to the Art, that scarce ever understood what the *Mathematicks* were ; yet why should it deter any Artist from the Use and Practice thereof, seeing we may not only, with more ease and exactness, and with less fear of Errors and Mistakes, attain our desired Aim far better thereby, than can (possibly) be done with any other Instrument whatsoever, as is well known to all Practical Surveyors, who are acquainted both with the Use of this and the rest? And yet I can't but highly commend the *Theodolite*, *Circumferenter*, and the *Peractor*, as Instruments very useful upon some occasions ; neither dare I reject, as useless, either the *Topographical Instrument*, and *Cross-staffe* of Mr. *Diggs*, the *Familiar Staffe* of Mr. *John Blagrave*, the *Geodetical Staffe*, and *Topographical Glass* of Mr. *Arthur Hopton*, the *Sector*, *Cross-Staffe*, and the *Pandoron* of my late Worthy Friend Mr. *George Attwell*, or any other commodious Invention that hath hitherto been wittily devised, for the exact Plotting, and speedy Mensuration of all manner of Superficies, as Land, and the like. But in regard the Authors themselves have in their own Works (to their exceeding Commendation) described both the Making and Use of the said Instruments, I should here but tire my Readers to reiterate what they have already shewed elsewhere, and so make these few Lines swell beyond their intended Bounds: And besides, Mr. *Aaron Rathborne*, in the beginning of his *Third Book*, and my Loving Friend, Mr. *William Leybourn* in the first five Chapters of his *Second Book*, have very well saved me that labour ; where they have excellently treated, both of the Composition and Use of the most Material and Commodious Instruments now in being, to which the *Semicircle* may be added, as being inferiour to none of the forementioned. Wherefore I shall now come to speak of the Composition of the *Plain Table*, which indeed is the Instrument, of whose Use alone we shall afterwards treat.

This Instrument (commonly known by the Name of *Geometrical*, or *Plain Table*) is in the Fashion of a Parallelogram, or Long Square, containing in Length about 14 Inches and a half, and in Breadth

Breadth 11 Inches; and were it not for warping, it might be made of one Board, but for avoiding that, and for the conveniency of Carriage, the best way (as they are usually made) is to have it of three Boards in breadth, with a Ledge at each end for holding them together, and making the Table of due length; whereunto belongeth a joynted Frame, that when the five Boards are set together, and a Sheet of Paper put thereon, the Frame may bind the same so fast and smooth upon the Table, that when you come into the Field, you may neatly describe a Plot of your Land, Wood-Ground, or other Inclosure, upon the same, as shall be afterwards shewed.

Again, Let the Sides of the Frame of the Table be divided into equal parts, or Scales, for the drawing of Parallel Lines when you shift your Paper, and put on another Sheet. And on the other side your Frame, it would be very necessary to have projected upon it, the 360 Degrees of the Circle from a Center made about the middle of the Table, which will be of excellent use in Wet and Stormy-Weather (as my Worthy Friend Mr. *Leybourn* well adviseth) when as you cannot keep a Sheet of Paper upon the Table.

To this Instrument there belongeth a Rule, or Index of Brass, which must contain in length at least 16 Inches, in breadth about 2 Inches, and in thickness $\frac{1}{7}$ of an Inch. Upon this Index are to be placed two Sights, both of one length, the one having a Slit below, and a Thread above, and the other a Slit above, and a Thread below, serving to look forward and backward, when you are upon Plotting; and these Sights must be so placed upon the Ruler, either with Screws, or square Mortisses, that both the Sights may be equi-distant from the fiducial edge of the Ruler. Moreover, upon the Face, or upper part of this Ruler, are several Scales of equal Divisions, as of 10. 12. 16. 20. 24. and 32 parts in an Inch; serving to lay down the Plot of a Field according to what proportion shall be thought most convenient for that purpose. There also belongeth to this Instrument a Box and a Needle, which is to be placed on the Side of the Table, with two Screws; and in the bottom of the Box is placed a Chard, divided into 360 Degrees, which is covered over with clear Glass.

Lastly, On the backside of the Table is a Socket of Brass fastned to the Table with three Screws, into which Socket must be put the Head of the Three-legged Staff, which for Portability, is usually joynted in the middle.

CHAP. II.

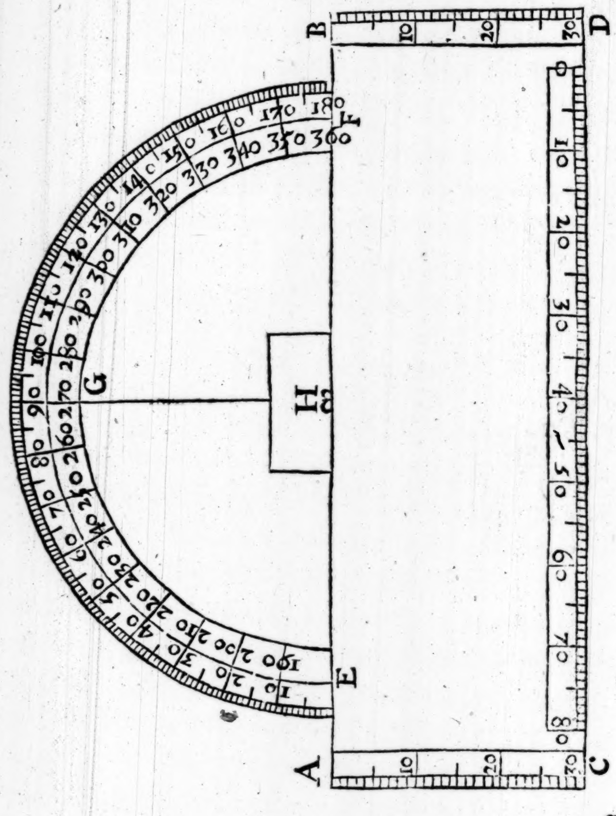
The Use of the Scale and Protractor.

UPON the Brass Rule are several Scales of equal parts, as I said before, as of 10. 12. 16. 24. and 32 parts in an Inch, whose Use are principally to lay down, upon Paper, the length of any Line taken in the Field in Perches.

Upon the same Rule (or upon the Pocket-Rule) is a Scale of Chords, which serveth to protract and lay down upon Paper, the just quantity of an Angle; for if you open the Compasses to 60 Degrees thereof, and with that extent describe an Arch, you may therein set off what Degrees and Minutes you please, by taking the just Extension thereof from the Scale, with the help of your Compasses.

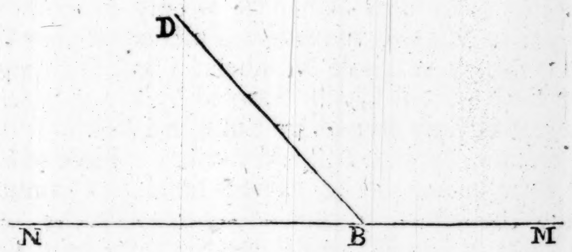
But in the Practice of *Survey*, when the Weather is moist, and you are forced to take the Quantity of Angles by the Degrees on the Frame of the Table, or by a Semicircle, you may speedily perform the Work thereof by the Protractor.

The Figure of the Protractor, and its Scale.



Suppose

Suppose it be required to lay down on Paper the true quantity of an Angle of 50 Degrees taken in the Field, upon the Line MN,



from the Point B, upon which Point place the Center of your Protractor, in such wise, that the Meridian Line thereof, noted with the Letters AHB, may lie exactly upon the Line MBN; so that the Center of the Protractor noted with H, lie exactly upon the Point B; then in the Limb of the Semicircle at 50 Degrees, note the Point D, and draw the Line BD; so shall the Angle DBM contain 50 Degrees.

But if MBD were an Angle given, and the Quantity thereof required, then place the Protractor as before, and the Limb of the Semicircle will tell you that the Angle DBM is 50 Degrees, and (laying the Meridian Line of the Protractor upon the Line DB) it will give you the Angle NBD to be 130 Degrees, it being the Complement of the Angle DBM to the Semicircle 180 Degrees. But these things you will find so easie, that I need not insist further thereon.

CHAP. III.

Of the Chain, with the Division and Use thereof.

SOME Surveyors still Work by a Chain of 16 parts in Perch, others (as Mr. *Gunter* in his Description and use of the Sector, Cross-Staffe, *&c.*) divide the whole Chain of 4 Perches, into 100 Links; but Mr. *Aaron Rathborne* in his Surveyor, Printed *Anno 1616.* makes Division of every Perch into 100 parts: That is to say, first he divides each Perch into 10 parts, call'd Primes; each Prime whereof is again sub-divided into 10 parts more, which he calls Seconds; and this is commonly called the Decimal-Chain. But the Chain that I have usually made for my self, contains in each Pole 20 Links, so that in the Use thereof, I apply it to Decimal Operations, wherein to avoid Prolixity, I account two Links

to be one Prime, and one Link to be five Seconds; and yet notwithstanding in *Geodæsie*, or Land-measure (unless it be out of Curiosity) it is needless to go nearer than a Link of your Chain. But seeing my intent in this Chapter, is only to shew you how you may speedily Multiply the several Fractions of your Chain together, as if they were whole Numbers: I will first shew how to effect it by the Decimal-Chain invented by Mr. *Rathborne*; and then afterwards by my own of 20 Links in a Perch.

First therefore, Suppose I should measure a Piece of Land (lying in the Form of an Oblong, as most Lands in Common Fields do) and find the same to contain in Length 42 Perches, 6 Primes, and 4 Seconds; in Breadth 12 Perches, 8 Primes, and 4 Seconds; therefore to effect my Desire, I place my Numbers in all respects, as is usually done in Whole Numbers; and over every Fraction of the Multiplicand, place a Prick, or Point, and at the end of the Multiplier, place also as many Points as there are Fractions in that Number; then Multiply your two Sums together, as though they were Whole Numbers, and the Product will tell you how many Perches, and parts of a Perch, are in that parcel of Land; only you must observe, That so many Pricks as you made, so many Figures must you cut off from your Product to the Right Hand; so will you have the true Value of your Land in Perches, and parts of a Perch; as the Example following will more clearly demonstrate.

An Example of a piece of Ground, whose Length is 42 Perches, 6 Primes, 4 Seconds; the Breadth 12 Perches, 8 Primes, 4 Seconds; which are thus Multiplied together, as if they were Whole Numbers.

Here you see there are two Fractions in the Multiplicand, which are noted with two Pricks over Head, and as many in the Multiplier, as they are marked towards the Right Hand; so that, as you see, after the Operation is performed, because I have four Fractions, I must strike off with a Dash of my Pen, the four last Figures of the Product towards the Right Hand, and then will the Product stand thus, 5474|976. which intimate, that there are contained in this piece of Land, 547 whole Perches, and $\frac{4976}{10000}$ parts of a Perch, which is near upon half a Perch.

```
      . .
    4264
    1284..
   ------
   17056
  34112
  8528
 4264
 --------
 5474|976
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But because a Chain of 20 Links in a Perch is more ready, and altogether as exact as the former, I will also shew you in one Operation how you may readily and truly work thereby. Therefore suppose a piece of Land be in length 36 Perches, and 16 Links, and in breadth 3 Perches, and 2 Links; and because I have 20 Links in a Perch, therefore that I may perform the Operation in a Decimal-way, I account but half the Number of my Links, and then the Sums will stand as follow.

Now

Now Multiplying the two Sums together, as before was done, and marking the Fraction, I find the Sum of the Multiplication to be 11408. and in regard of the two Fractions, I strike off the two last Figures of my Product towards the Right Hand, and then the Sum will stand on this wise, 114.08. which is 114 Perches, and one 8th part of a 100; and so much is the said piece of Land, according to Statute Measure.

$$\begin{array}{r} 368 \\ 31. \\ \hline 368 \\ 1104 \\ \hline 11408. \end{array}$$

But if the Land had been 36 Perches, and 9 Links in length; and 3 Perches, and 3 Links in breadth; then you are to place the Numbers thus.

Multiplying the two Sums together, and from the Product cut off the four last Figures, because of the four Fractions, and then the Sum will stand on this wise 114.8175, so that the Land contains 114 Perches, and above three parts of a *Perch*.

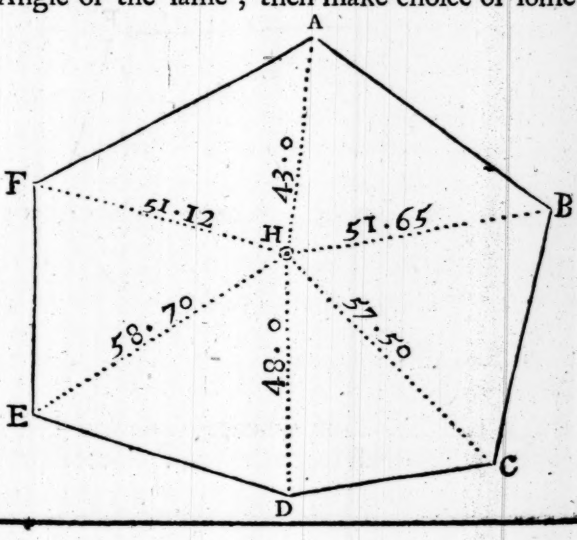
But the Description and Use of this Chain, is more fully Illustrated in *Chap.* 2. of the *Appendix*; and in *Chap.* 3. of the said *Appendix*, is the Description and Use of a New Decimal Scale, exactly fitted to the Division of this Chain.

$$\begin{array}{r} 3645 \\ 315.. \\ \hline 18225 \\ 3645 \\ 10935 \\ \hline 1148175 \end{array}$$

CHAP. IV.

To take the true Plot of a Field at one Station taken in any part thereof, from whence you may see all the Angles, or Corners, of the same.

SUppose ABCDEF, be a Field to be measured. First, cause white Papers, or visible Marks, to be set up in every Corner, or Angle of the same; then make choice of some conveni-



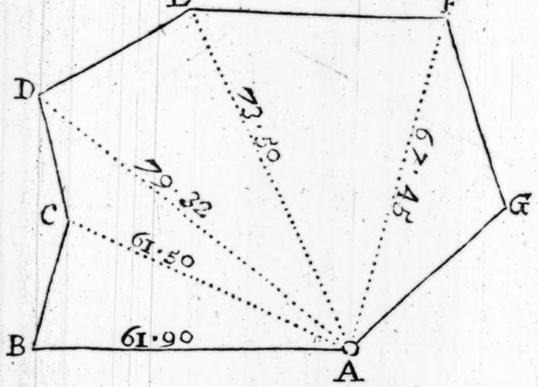
ent

ent place therein, from whence you may best view all the Angles thereof; in which place, as at H, plant your Table (covered with a Sheet of clean Paper), and so fasten it with the Skrew-pin, that the Table stir not, till your Work be finished. Then placing your Index upon the Table, lay the Fiducial-line thereof upon the point H, representing the place of your Station; and then direct your sight to A, and draw a Line with your Compass-point by the side of the Index upon the Paper; which done, direct your sight to B (still keeping the edge of the Index upon the point H) and draw a Line, as before; and so in like manner direct your Index to C, D, E, and F, drawing lines upon the Paper by the edge of your Index, with the point of your Compass, and having finished the same, measure with your Chain the distance of every of those Marks, from the place of your Station at H, and then by the help of your Scale and Compasses, set the same Distances, from the point of Station at H, in the Lines drawn upon the Table, making a small prick with your Compass-point, at the end of every of them; then with the point of your Black-lead Pencil, draw a small Line from one point to another, as namely from A to B, from B to C, and from C to D, *&c.* so shall you have upon the Table, the exact Plot of your Field.

CHAP. V.

To take the Plot of any Field at one station, in any one Angle thereof, from whence all the other Angles may be seen.

FIrst, as before, set up Whites in every Corner of the Field, as at BCDEF and G; then make choice of the most con-



venient Angle therein, from whence you may best view all the rest, as A, which shall represent your place of station; and having

having fixed your Table there, as before is taught, apply the the Index to the point A, and direct the sights to B; then draw the Line A B upon the Paper, and with your Chain measure the Length thereof, and set it down by the help of your Scale, from A to B.

Then, *secondly*, from the said point A, turn your sights to C, your second Mark; and then draw with the one point of your Compasses, upon the Paper, the Line A C, measuring the Distance, and setting down the Length by the same Scale, as you was before taught.

In like manner direct your sights to D, E, F, and G, and drawing Lines upon the Paper, measure with your Chain, the Distance of each of the same Angles from your Station-point at A, where your Table is planted; then, with your Compasses, take from the Scale the said Distances respectively, and set them down from the point A, upon the several Lines, A D, A E, A F, A G; so shall you have upon the Paper, the points A B C D E F, by which Marks you may, by the help of a Black-lead Pencil, finely pointed, describe the Lines A B, B C, C D, D E, E F, F G, G A, which will exactly represent the just Figure of your Field upon the Table, which will be greater, or lesser, according to the Scale you work by.

CHAP. VI.

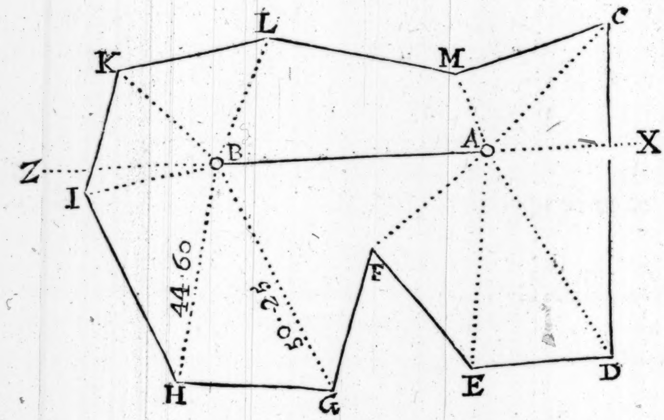
To take the Plot of a Field at two Stations, when as all the Angles thereof cannot be seen at one.

IT oftentimes hapneth, through Hills, or the Spaciousness of the Ground, that you cannot from any one place of the Field, see all the Corners and Angles thereof; in which Case it behoveth the Surveyor to make choice of two of the most convenient places within the same: So that here you are to perform that by the help of two Stations, which before was effected at one.

Suppose therefore, that the Figure noted with the Letters C D E F G H I K L M, be a Field to be plotted, which lieth so, that from no one place all the Angles thereof can be seen; therefore I make choice of two places within the same, for my Stations, as A and B, where I can conveniently view all the Angles. And first, I plant my Table in A, from whence I can see the Angles M C D E F; then placing the Edge of my Index (after the Table is fixed) upon the point A, I direct my sights severally to all the Angles within my View, as to M C D E F, drawing Lines as

as before is directed in the preceding Chapters; which done, I measure every of them with my Chain, and note them down from my Scale, as formerly I shew'd.

Then (my Table remaining fix'd) I view the other parts of the Field, and make choice of the Point B for my second Station, because from thence I can see all the other Angles of the Field; then setting up a white, or other Beacon there, I go back to my first Station at A, (where my Table stands fix'd, as I left it)



upon which point I move my Index, till through the sights thereof, I espy the Mark at B; which done, I strike a Line by the fiducial Edge of the Index, with my Compass-point, extending it quite over the Table, as is represented by the Line Z X; which being thus performed, I measure the stationary Distance A B, finding it 53. Perches, 5. Links (or 25. Seconds,) which I set down from A to B, the place of my second Station, by the help of my Scale and Compasses, in such sort as I have formerly shewed.

Secondly, I plant my Table upon the Point B, and laying the Edge of my Index upon the Line Z X, I turn the Table about, till through the sights I behold my first Station at A; then I skrew the Table fast to the Staff; afterwards moving my Index upon the point B, I direct the sights first to G, drawing the obscure Line B G, containing 50 Perches, 5 Links: Then again I direct the Index to the Angle H, and find it distant from my station 44 Perches, 12 Links, or 60 Seconds; and thus turning my Index about upon the point B, I draw obscure Lines towards the other Angles at I, K, and L, as I did before, and measuring their respective Distances with my Chain, I prick down the said points I, K, and L, upon my Paper, ever observing to take off with my Compasses, upon the Scale, the exact quantity of Perches and Parts, measured with the Chain. Lastly, the several Points, or Angles of the Field, at C D E F G H I K L and M, being found out, and mark'd upon my Paper, I draw the

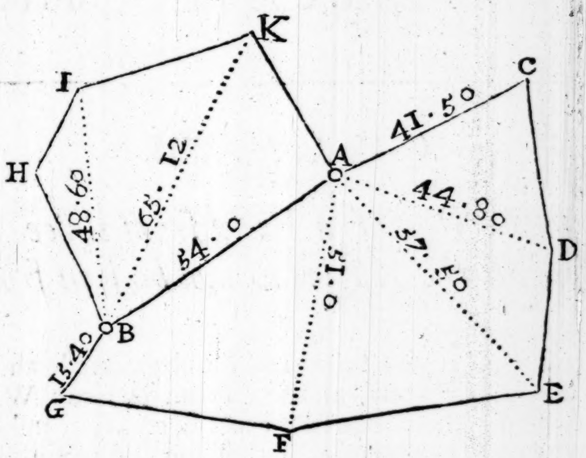
Lines

Lines CD, DE, EF, FG, GH, HI, IK, KL, LM, and MC, which will repreſent upon the Table, the exact Plot of the Field to be meaſured.

CHAP. VII.

To take the Plot of a Field from two Angles, when as all the ſaid Field cannot be ſeen from one.

THis work differs little from the former, for wheras there you made choice of two places within the Field, for your two ſtations, from whence you may view all the angles; ſo here you muſt take two of the moſt convenient angles for the ſame purpoſe. Therefore ſuppoſe this figure A C D E F G B H I K, be a Field to be plotted, whoſe angles cannot all be ſeen from any one angle thereof, but as I go about the Field to view the ſame,



I immediately ſee, that the Angles A and B, are the moſt fit and convenient for my purpoſe, being ſeated upon higher ground than any of the other; wherefore, ſetting up a Beacon in the Angle B, I repair to A, where I plant my Table, and faſten it with the Screw-pin; Then upon the point A, I apply the fiducial edge of my Index, and direct the Sights thereof to C, and meaſuring the ſaid diſtance with my Chain 41.50; prick it down upon the paper from A to C, according to its extention upon the Scale, and I make a prick with my compaſs-point, which will repreſent the point C. This done, I turn my index towards D, till

through the Sights thereof I espie my Beacon there placed, then measuring the distance 44. 08, I set it down in the said line, and make a prick upon the paper, which will represent the point D. In like manner I deal with the Angles at E and F.

Then (my Table remaining fixed) I turn my Index about upon the point A, till through the Sights thereof I discover the point of my second station at B, and see the Thread cut the middle of my Beacon there standing: Then I measure the distance finding it 54. 00, which known, I open my Compasses to 54. upon my Scale of 32. to an inch, and prick it down in the line A B to B, where I again make a mark thus (⊙) upon my paper, for the place of my second station. Afterwards, I remove my Table from A to B (leaving a Beacon at A, when I came from thence) and placing my Index upon the stationary line B A, I turn the Table about, till at length I see (through the sights thereof) the Beacon I set up at the place of my first station; Then fixing my Table, as formerly I shew'd, I direct my sights to the severall marks, at G, H, I, and K, and strike lines upon the paper towards them; and measuring particularly their distances, I set 'em (by the help of my Scale) from B, to G H I and K, where I make small pricks with my Compass-point; and then drawing lines successively bout the Perimeter, from point to point, you shall have the exact Simmetry and proportion of your Field, as it is represented in the figure by the former lines AC, CD, DE, EF, FG, GHI, IK, and KA.

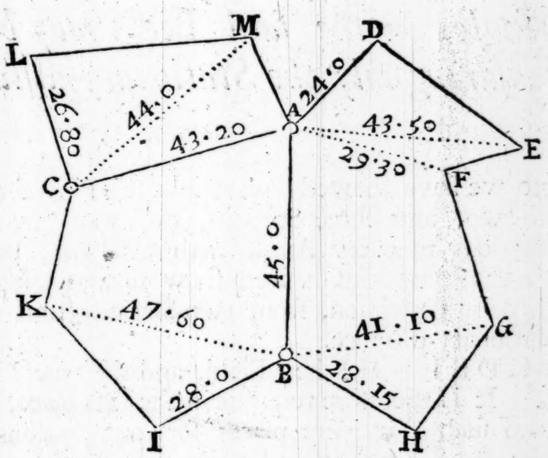
CHAP. VIII.

To take the Plot of a Field from three Angles when all the Angles cannot be seen from two.

SUppose this Figure be a Field to be plotted, and from no two Angles thereof, all the rest can be seen: Wherefore I make choice of three Angles, as A, B, and C; and beginning first at B, I turn my Index upon that point, directing it to I, H, and G, drawing forth the lines BI, BH, and BG, and setting down upon the same (by help of my Scale and Compasses) the particular dimensions found by the Chain, as is there expressed, I note the points I, H, and G.

Secondly, Setting the Index upon the point B, I turn it forward towards A, till thro' the sights thereof I see the Beacon there erected, to which I strike a Line upon the Paper along by the edge of the Index, as the Line B; A then I measure it with my Chain, finding it 45 Perches exactly, which taken off my Scale, I set the same extent, with my Compasses from B to A, making such a mark as this (⊙) which shall represent my second station, from whence (as before

before) having placed the Index, upon the Line A B and set the sights thereof to cut the point B, I strike the Lines A D, A E, A F, and likewise measure them with the Chain, making a little prick upon the Paper at D, E, and F, which shall shew upon the Table the true Symmetry and shape of that part of the Field.



Thirdly, The Table standing steady, and fixed upon the point of that Second station A, and also rectified by the Line A B (for fear the Table should be alter'd) you are then to turn the Index upon the point A, towards C, and when you shall (through the sights thereof) espie the Beacon at C, draw a Line along by the edge of your Index towards C (which for exactness, extend forward and backward to the extremity of the sheet of Paper upon your Table) then measure the stationary distance A C, 43 *P* 20, to which open your Compasses upon your Scale, and set it down from A to C, Lastly, coming to C, you are there to erect your Table, and upon the Line C A set the Index, and then turn the Table gently, till through the Sights, you see the Beacon at your second station A, then screwing fast the Table, direct the Sights to the several Angles at K, L, and M, towards which (upon your Paper) strike Lines with one point of your Compasses, by the fiducial Line, or edge of your Index, and then measuring the distances of every one of the said Angles from you, set down each measure in its own proper Line respectively, as in the former Figure you may perceive, so will you have the true Plot of the Field. But in case that from three stations, you could not have seen all the Angles in the said Field; then after you had finished these, you should have removed your Table to a fourth, and there to have performed the rest, or as many as there you could, and if any remaining, to chuse a place for a fifth and a sixth station, *&c.* till you have finished; for the work will in effect be the same with the former.

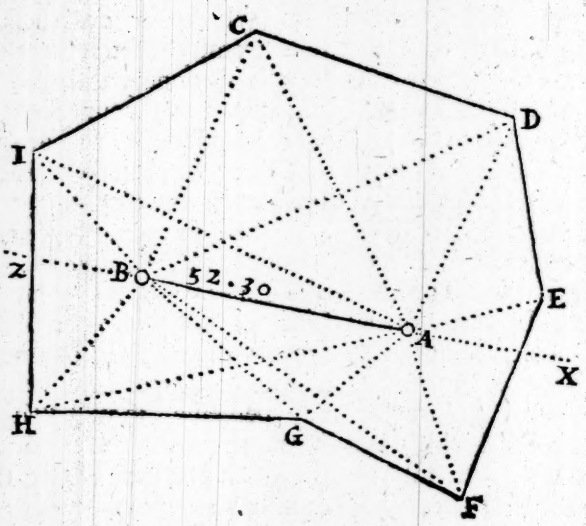
Gg 2 CHAP.

CHAP. IX.

To take the Plot of a Field at two Stations within the same, from either of which all the Angles in the said Field may be seen, by measuring only the Stationary-distance.

HItherto we have shewed how to take the Plot of a Field, at one, two, and three Stations, or more, by measuring from the Stations to every Angle with a Chain; but we shall now, and in the following Chapter, shew how to effect the same more speedily by Projection, from two Stations, and measuring only the Stationary-distance.

Suppose C D E F G H I be a Field, and the true Plot thereof is required. It is therefore requisite in the first place, to make choice of two such convenient places for your Stations, as from thence all the Angles in the said Field may be seen; as A and B, (which for the avoiding of Error, must be of a considerable distance,) then having set up Whites, or other marks in every Angle of the Field, plant your Table at A; where, upon the point thus marked (⊙,) lay the edge of your Index, and turn it about towards C, till through the Sights thereof, you espie the White,



or other mark there placed, and then by the edge of your Index, draw the Line A C. Secondly, Turn your Index towards D, and draw the Line A D; and so in like manner proceed till you have

have drawn Lines from your point of Station A, to every Angle in the Field, as is lively expressed in the Figure.

Afterward (your Table standing fixed) direct your sights to your second Station at B, and draw a Line by the edge of your Index (and be sure to extend it far enough, that when you come to direct your sight back again to the first Station, you may not fail to lay your Index aright upon the Stationary Line,) Then exactly measure the interval of your Stations, which in this Example we find 52 Perches, 3 Primes, 0 Sec. which set down from A to B, then setting your Table at B, place the Index upon the Line Z, B, A, X, and turn it, till through the sights, you espie the point of your first Station at A, in which positure let your Table be fixed; which done, lay your Index upon B, and direct the Sights to all the Angles in the Field as you did from the first Station at A, drawing small Lines with the point of your Compasses along by the edge of the Index, and at the intersections of these Lines, are the Angles of the Field, as they are represented upon the Paper.

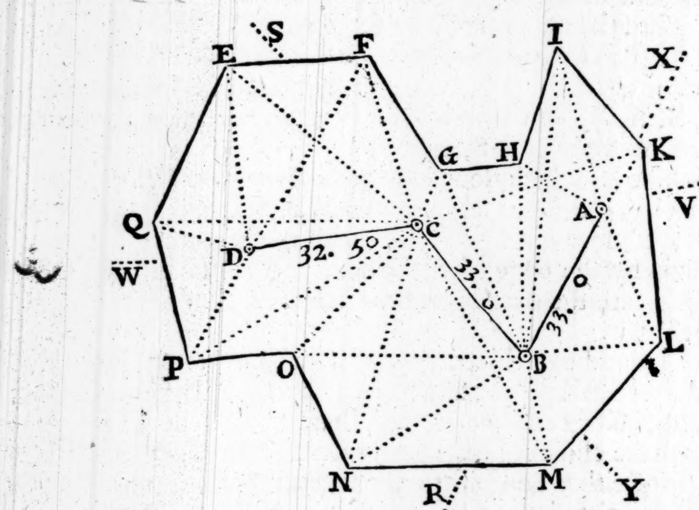
Notwithstanding, this manner of working is very facile, and of wonderful celerity, yet sometimes, in respect of the acuity of the Angles, it is subject to error, and therefore it behoveth my Surveyor to make choice of such convenient Stations, that all Lines drawn from either Station to the several Angles, may intersect each other with as large Angles as may be: And if it be but discreetly performed, you shall not only find it of quick dispatch, but also accurate and marvellous useful; especially when you would on a sudden know the just quantity of a Field, and want time to measure it otherwise.

CHAP. X.

To take the Plot of a Field at divers Stations, by measuring only the Stationary-distances.

THE work of this Chapter differs not much from the last, and therefore I shall with brevity shew how to effect it. Suppose this Figure represent a Field, whose Plot is required. First, having set up Beacons in every Angle of the Field, make choice of the most convenient place for your first Station, which let be at A, where planting your Table, and setting the Index upon the Point A, direct your Sights to as many Angles severally, as are within your view, as to H, I, K, L, and accordingly strike Lines to every of them, as is before declared, which done, make

make choice of a fit place for your second Station, where you may not only see all the same Angles you beheld from the first Station, but as many more as you can, which imagine at B, then upon my Table standing fixed at A, I direct the sights to B, and measure the stationary distance A B 33 perches; then taking up my Table at A, and planting it at B, I place the Index upon the



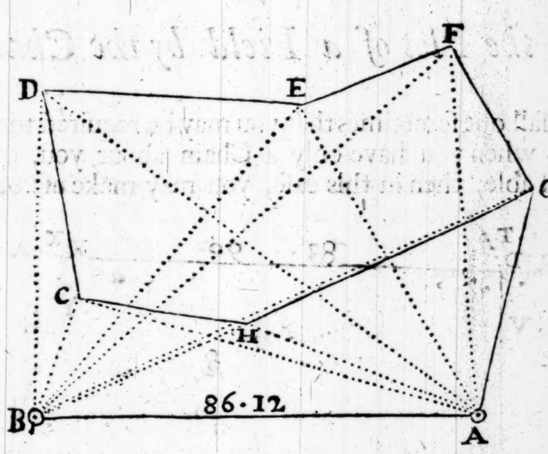
Line R B A X, and turn it gently about till through the Sights I see the Mark set up at my first Station A, and then removing the Index orderly, I direct the sights to all the former Angles (except K, which I cannot yet see) namely to H, I, and L, making a little prick where these Lines intersect the former; which done, observe what other Angles you can discover, as those at M, N, O, and G, and to these direct your Index, and accordingly, to each of them draw small Lines with the point of your Compasses, as before, then (letting your Table stand still at B,) find out your third Station, as at C, where you may not only view these former Angles at G, M, N, and O, and the Angle K, which at B could not be seen, but as many other yet unseen, as you can; then from B, direct your sight to C, till you espie the same, and measure from B to C 33 *p.* 0, which set from B to C in the Line Y S, When this is performed, plant your Table at C, and laying the Index exactly upon the Line S C B Y, move the Table till through the sights, you discover the point B, and then again direct the Index to those former Angles G, O, N, M, drawing small Lines till they intersect the former. Afterwards consider what other Angles you shall find within your view, as F, E, Q, P, being all the other Angles in the Field, till now unseen, to which direct your Index, and describe them as before. Lastly, your Table yet remaining fixed, set the Index upon C, and turn it to D (your last station) draw the Line V C D W, in which from C, measure the distance of your last Station 32 *p*, 50, placing it from

from C to D. Now having found the point D, lay your Index upon the line W D C V, and then turn the Table till you see the point C, and so placing the Index upon the point of the last station at D, I direct it to all those sever al Angles at F, E, Q, P, and where those lines intersect the former, make small marks, then draw a line from one Point to another where the lines intersect, as EF, FG, GH, HI, IK, KL, LM, MN, NO, OP, PQ, QE, which will represent upon your Table, the true Plot and Simmetry of the said Field.

CHAP. XI.

To take the Plot of a Field remote from you, at two Stations, when you are not permitted to to come within it.

IT often times hapneth that you are call'd to measure a Field, and may not (either by Waters, Moorish ground, danger of Suit, or other impediment) enter into the same, yet you shall find the work easie enough to be performed, for it differs very



little from that manner of projection in the ninth Chapter, only that there your stations were both made within the Ground, and here they are without.

Suppose the figure C D E F G H, be a Field, wherein I may in no wise enter, yet of necessity must the Plot thereof be taken, and therefore I make choice of two convenient stations without the same, as A, and B, from each of which I can see all the Angles of the said Field; and having planted my Table at A, (the place of my first station) I place the Fiducial-Line of my

Index

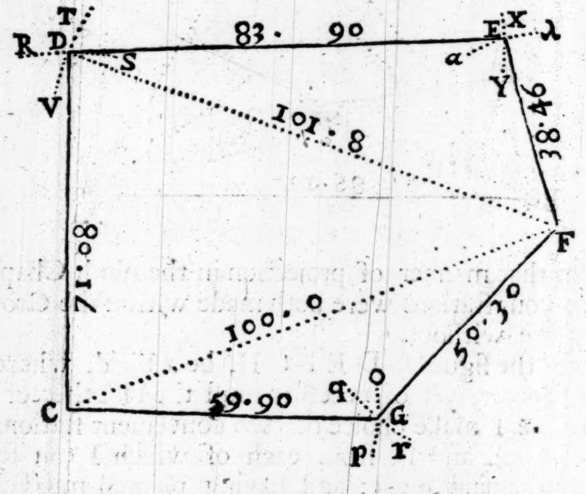
Index thereupon, and direct it (as before was shewed) to all the Angles of the Field respectively, drawing Lines with the point of my Compass, as AG, AF, AE, AD, AC, AH. Then (my Table remained fixed) from A, I direct the Index towards B, till through the Sights thereof, I espy the Beacon there placed, and having drawn out the Stationary Line A B of sufficient length, I measure the distance thereof in the Field, *86 p. 12 l.* and place it on the Paper from A to B, then planting the Table at B, place your Index upon the Stationary Line B A, and then softly move the Table, till through the Sights, you behold the Beacon standing at A, which being effected, direct your Index to all the several Angles of the Field, as you did before at A; and the intersections of these Lines, will represent the several Angles of the Field, from which drawing the Lines CD, DE, EF, FG, GH, HC, it will shew the true Plot and Proportion of the Field.

But if all the Angles cannot be seen from two Stations, you may take three or four, and perform your work without, as you did within the Plot, in the last Chapter; but I need not further explain this Matter, for he that aright understands the one, cannot be ignorant of the other, they both depending upon one and the same Principle,

CHAP. XII.

To take the Plot of a Field by the Chain only.

IT may fall out sometimes that you may be required to measure a Field, when you have only a Chain about you, and cannot procure a Table, then in this case, you may make use of the way



here delivered, which in small inclosures, where the Lines are not much curved, will stand you in excellent stead. Let

Let this figure C D E F G represent a Field to be Plotted. First, I measure with my Chain from F to C, which contains 100 *p* 0, then I measure the side C G 59 *p* 90, and the side FG 50 *p* 30.

Which done, I open my Compasses upon the Scale to 100 *p* 0, and setting one Foot in the Point F, with the other I mark the Point C, next I take from my Scale 59 *p* 90, and setting one Foot in C, with the other I draw the Arch o P, then again with the distance F G 50 *p* 30, setting one Foot in F, draw the Arch q r, cutting the former Arch o P, in G; then drawing two lines from F and C to G, we have the Triangle F C G exactly described, according to the tenth Problem of the first Book.

Secondly, in the Triangle C D F, the side CD, contains 71 *p* 08, and the side F D 101 *p* 08, therefore (from my Scale) I take 71 *p* 08 and setting one Foot of my Compasses in the Point C, with the other I describe the Arch RS; next I take 101 *p* 08, (from my Scale) and setting one Foot in F, with the other I describe the Arch VT, crossing the former Arch R S in the point D, then drawing two lines from C and D to F, we have limited the Triangle C D F.

Thirdly, in the Triangle D E F, because the side DE contains 83 *p* 90, and the side E F 38 *p* 46; take 83 *p* 90, from your Scale, and placeing one Foot in D, with the other describe the Arch X Y, then open your Compasses to 38 *p* 46, and setting one Foot in F, with the other draw the Arch $\alpha\lambda$, intersecting the former Arch X Y in the Point E; Lastly extending two lines from D and F to E, you shall have the Triangle D E F, and so you have the entire Plot of the Field C D E F G, which is as exactly wrought, as if the Plot had been taken by your Index upon the Table.

More Examples I might add but he that rightly understands this, may perform any other. And albeit in the former Chapters, I have sufficiently shewed how my Reader may Plot any Piece of Ground whatsoever, several ways, after the most plain and easie Method that can be devised (which I hope will yield abundant satisfaction to all that Read and Practice it) yet forasmuch as it is often required to take the Plot of a whole Mannor (or any part of a Mannor) consisting of divers Severals, as Arable Pasture and Wood-grounds, it will be here necessary and convenient, to shew you an exact and perfect way how the same may speedily be effected; and to this End I shall, in the following Chapter, endeavour to explain the same, by setting forth to your view the best way to Plot any irregular ground, by going round about the same, and afterward shall give you a perfect and lively Model and Pattern of a Field, consisting of sundry Parts, wherein each Ground is to be Plotted and laid down together in an Intire Plot upon Paper, according to the just order and Proportion, as it lies in the Field.

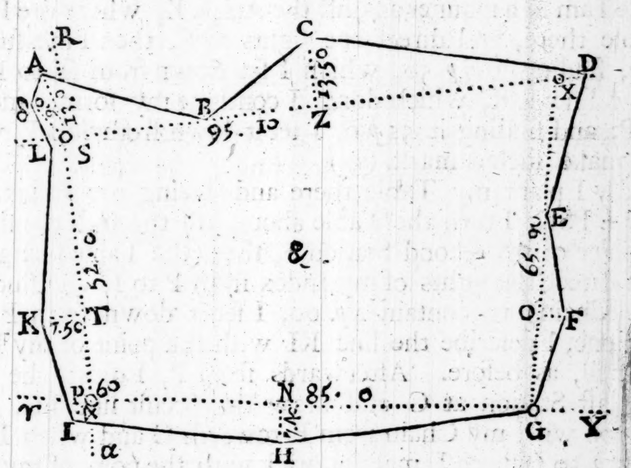
CHAP. XIII.

To take the Plot of a Field, by measuring, from one Angle to another, round about the same.

IN the former Chapters we have shewed after the most easie and artificial ways yet invented, how the Plot of a Field may be had and obtained several ways; yet because in Old Inclosure, it happens for the most part, that you can seldom find any of the Hedges straight, any considerable distance, and ofttimes one side is bounded with some River, or other crooked Gutter, it will be requisite in this Chapter to shew you the most Common and Ordinary way used by my self, and other Practical Surveyors, which I shall here the more willingly do, in regard this manner of Working (which I know by long experience to be the most absolute of all others) is hitherto neglected by all former Authors, that have written upon this Subject; at least, they have so slenderly handled the same (perhaps for want of use and Practice) that very few, or none, that have Read their Works can reap any Profit from them, and therefore I shall here the more amply insist thereon. And to the end I might not omit any thing that may be Commodious to the Reader, it will in the first Place be very requisite to shew the young Practitioner what Scale is most fit for his purpose, in Plotting and laying out Inclosure, and other Grounds, First therefore in small Fields, that exceed not 60 or 70 Acres, you may Plot by a Scale of 10 or 12 parts in an Inch, and so bring your intended Plot all upon one sheet of Paper. But if your Field be larger, and under 200 Acres you may use a Scale of 16. If greater, and yet under 300 Acres, the Scale of 20, but if under 500 Acres, the Scale of 24, may serve your turn, however those of 16 and 20 in the Inch, are the ordinary and common Scales now used, for though your Ground contain 500, 1000, or 2000 Acres, yet may the Surveyor very aptly use them, by shifting of Paper, and afterwards in the House, putting the several Sheets together with Mouth-glew and so make an entire Plot thereof; yet if your Field consist of three or four thousand Acres, and you would have the Plot of a less proportion, you may use a Scale of 24 or 32 parts in the Inch, though for my part I never yet, these 25 years, that I have (in a manner) daily practiced the Art, ever used any Scale above 24. But because I would not exceed my intended limits, neither have the Diagrams too large for an ordinary Octavo, I shall (as before) in all my examples make use of a Scale of 32 in the Inch. But to my purpose.

Suppose

ſuppoſe this irregular Figure ABCDEFGHIKL δ repreſent Field, into which when I firſt enter, I cauſe Whites to be ſet up in every Corner of the ſame, which done, I make choice of the moſt convenient Angles thereof for my Stations, not regard ing their number whether I make 3,4,5, or 6. Stations, yet th fewer the better, but you muſt always take ſo many, as you



may clearly ſee from one to another. Thus in the former figure, I make choice of my firſt Station at X, as a place moſt fit for my purpoſe, in regard from thence I can ſee the Point L, and therefore I ſend one with a Beacon to S, ſo as when I go on in the Line XS, I may make a tangent at B, then planting my Table at X, I direct my Index to D, and ſtrike the line XD, which I meaſure, finding it 5*p* 30, and this I ſet down from X to D, and ſo make a Prick at D; this done, I direct the Index to S, And ſtrike the line XS, then I meaſure one in the ſaid Stationary line, till I come to Z, 47*p* 30 from X, where laying my Index upon the line SZX, I direct the ſights to X, and there fix the Table with the Screw-pin, then turning the Index upon the point Z, till through the ſights I eſpie the White at C, I then ſtrike the line ZC, and finding the diſtance 13*p*. 50, I ſet it down from Z to C, where I make a point, and draw the line DC. Then I go on with my former meaſure till I come to B 68*p* 40 and there I make a Point, and draw the line CB, which done, I go on carefully with my former Meaſure till I come to the place of my Second Station at S, finding the Stationary-diſtance XS 95*p* 10, which from my Scale I apply from X to S, where I make for my ſecond Station ſuch a mark as this (⊙) then planting my Table there (as I ſhewed before) I direct my ſights to A, δ and L, and I find SA 13*p*.0, Sδ 9*p*0. and SL 3*p*0, which ſet down ſeverally upon their reſpective lines, I have the points A, δ and L upon the Paper, then drawing the lines AB, Aδ and δL we have one the ſide of the Field deſcribed.

Secondly, I plant my Table at S, and laying the fiducial line of the Index upon the line SX, I move the Table till through the sights I espie the Point X, then fixing my Table, I turn my Index about upon the point S, till through the sights I see the Beacon at P, and by the edge of the Index, I draw the line SP, which done, I proceed, and measure on the Stationary-distance, but as I go on and am come to T, 35 *p* from my second Station, I observe I am in a manner against the Angle K, wherefore I plant my Table there, and direct the sights to K, then I measure the distance, finding it 7 *p* 50, which I set down from T to K, and draw the line LK, which done, I continue my former measure ST to P, and finding it 52 *p* 0, I set it down from S to P, where again I make such a mark. (⊙)

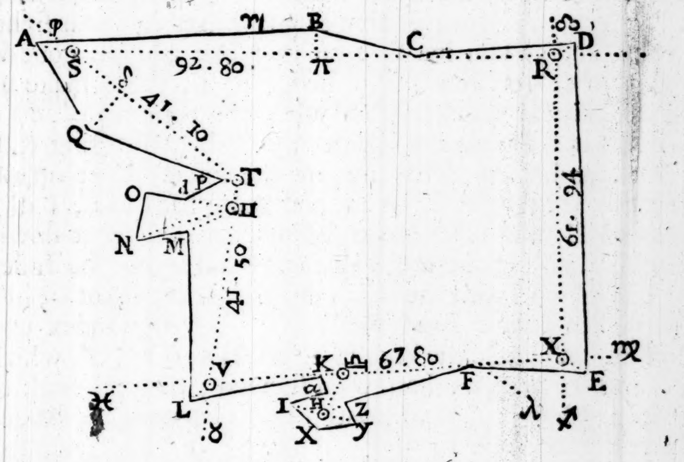
Thirdly I plant my Table there and laying my Index upon the line *a* PSK, I turn the Table about, till through the sights I see the place of my second Station S, then (the Table being there fixed) I direct the sights of my Index from P to I, and finding it (by the Chain) to contain 4 *p*. 60, I set it down from P to I, which done, I describe the line KI with the point of my Black-lead Pencil, as before. Afterwards from P, I direct the sights to my last Station at G and draw the occult line PG, then I measure on with my Chain from P towards G and when I come to N 37 *p* 10, (where I make a prick with the point of my Compasses) I perceive I am almost against the Angle H, then laying my Index upon the line PG, I turn the Table till I espie G with the Foresight, and P with the Back sight (by which you may know whether you be exactly in the line or no,) which done fix your Table, and direct your sights from N to H, pricking down the distance 7 *p* 40, and so with my Pencil describe the line IH, and after this is done, continue on your former measure began from P till you come to G (your last Station) which you shall find to be 85 *p* 0, which set down to G and mark it again thus. (⊙)

Lastly, At G plant your Table, and lay the Index exactly upon the Line YGP *r*, then turn the Table gently (for fear of shaking the Index off the Line) till through the Sights you espie the Beacon at P, which done, fix your Table and remove the Index, directing the Sights from G to the place of your first Station at X, where you began, and if it cut the mark, it is very probable that your plot is exact; then I measure on towards X, and when I have gone to O, 18 *p* 60 from G, I describe the Angle F, drawing the Line GF, and measuring still on, I find the tangent point E 39 *p* 30 from G, which I note with the point of my Compass, drawing the Lines FE and ED; which done, I continue on my former measure in the Line GX, finding it to be exactly 65 *p* 90, then because the same extent taken from the Scale, falls upon the Plot precisely in the point X, where I first began, it is an infallible sign that the Plot of the Field is exactly taken.

Now because this manner of plotting ground is the most excellent

cellent of any other, and is that which the Surveyor shall find at all times most apt for his Purpose, it will not be amiss to give you another Example, where a Field runs into many irregular Nooks and Corners, wherein I will use all possible brevity giving you only a short demonstration, in regard I have explained the former figure so fully already, so that he that knows how to perform this one, may quickly apprehend the work of the other: for they are both grounded upon one and the same Geometrical principle.

Let us suppose this Figure noted with the Letters A B C D E F Z Y X I α L M N O d P Q be a Field, whose Plot is required. First, (when you have set up Beacons in every Angle thereof) plant your Table at R, and from thence direct your Sights to S,



remembring as you measure on the Line R S to mark the Tangent at C, which falls out at 26 *p* 30, and after you have measured on to π 45 *p* 70, take the distance of that Angle, from your Stationary line, at B 4 *p* 60, which note as before, then Measuring on to S, you shall find the whole length of the Stationary line RS to be 92 *p* 80, at the end whereof mark the Point S. Afterwards setting your Index upon the said Stationary line, turn the Table till through the sights you see the Beacon at R, and there fix it, then Direct the sights from S to T, and as you measure on that line, Remember when you come to δ, to take the Angle Q, as before was shewed, but go on still measuring the Stationary line to T 41 *p* 10, and on your Paper at T, make a mark thus ($\odot$) for your second Station: and this being done, lay the Index upon the line λ T S φ and turn the Table, till through the sights you see the Beacon at S, in which Situation fix your Table, and then direct the sights to your 4th Station at V, drawing the line T V, (noting it on the edge of the paper on both sides the Table as at ♈ and ♉) then from my Station-point T, I direct the sights to P, which I measure, and describe, as I formerly

merly taught, drawing black lines from point to point, for the outbounds of my Plot, as I go on; which being performed, I measure the Stationary line T V 41 *p* 50 and mark the point V upon my Plot, but as I was measuring on that line, and had gone from the point of my third Station T to ♊ 6 *p* 0, I find That a convenient Place to take the Angles d,O,N and M, and therefore setting down my Table there, place the line TV, upon my Table Answerable to that in the Field, which I do by my Index, as before is shewed, then I direct the sights severally to all the said points, and after they are measured, let them be set down upon the Paper as before.

Fourthly, plant the Table at V, and laying the fiducial edge of the Index on the line ♉ V T ♈, turn the Table, till through the sights you see the Beacon at T, then fix the Table, and from the point V direct the sights to L, describing it as formerly. Afterwards (your Table being still fixed) set your sights from V to X, and as you measure on that line and are gone from V 21 *p* 95, that you touch the hedge at K, there make a mark and describe the line L K, and when you come to ♎ 26 *p* 0 from V, I find it a fit place to plant my Table, directing the sights to V ♓, and then (Screwing fast the Table) I set up a Beacon at H, near the Angles I,X,Y,Z, and going back to ♎, I direct my sights to H, and finding the distance 9 *p* 0, I set it down from ♎ to H, then I plant the Table at H and laying the Index upon the line H ♎, I turn the Table till I espie the Point ♎, in which scite (when I have fixed the Table) I lay the Index upon the point H, and strike the lines H α, HI, HX, HY, HZ, which measure and describe, as hath been shewed; then go back to your Stationary line VX, and continue on that measure formerly began, till you come to the Tangent point F 50 *p* c, from V, where make a Mark with the point of your Compasses and draw the line ZF, and keeping on measuring to X, I find it 67 *p* 80. Lastly, planting the Table at X in its due order, direct the sights to E striking the line XE, then measure its distance and set it down as before, drawing forth the lines FE and ED, which done lay the Index upon the line ♐ XR ♌; and if throught the sights you espie the point R, where you began, it is an argument your work is good, but for further Trial of the Truth thereof you are to measure the line XR upon the ground, and if it agrees exactly with your Plot, it shews that the Plot is truly taken.

In this like manner you may take the Plot of a Wood, or other Moorish Ground, by going round about, and making observation at every Angle, as you see it performed in the Work of this Chapter

There is one thing necessary to be observed, that when you are Plotting of Ground how you may know by your Chard and Needle whether you set your Index upon the right line, or not, for sometimes when you have many lines upon your Plot, and are in hast of Business, you may soon (through the Multiplicity

of lines) commit an error of this kind, and so when you come to close the Plot, you may discover yonr error, and not before: To avoid this Inconvenience, you are (as soon as you have Planted your Table at your first Station) to observe at what degree the Needle standeth, and if you work true, and mistake not your line, you shall find it stand upon the same Degree, at every Station round about the Field, but if there be any error in your Work (as there must of necessity when you direct the Index back upon a wrong line) then will your Needle stand upon some other Point distant from the former, in which you began, which will be more or less from the same, answerable to the reflection of the line you took from the true one. Let me therefore advise, that at every Station you have special regard hereunto; so that if you chance at any time to fail, you may rectifie your error, before you depart from that Station.

And now I am speaking of the Chard and Needle in your Table, I will not advise you at any time to plant the Table thereby, as some do; for I well know it is too small and insufficient for that purpose; but rather (as I have all along taught) to make use of fore-sight and back-sight, from station to station round about the Field. And thus much I thought fit to admonish you of.

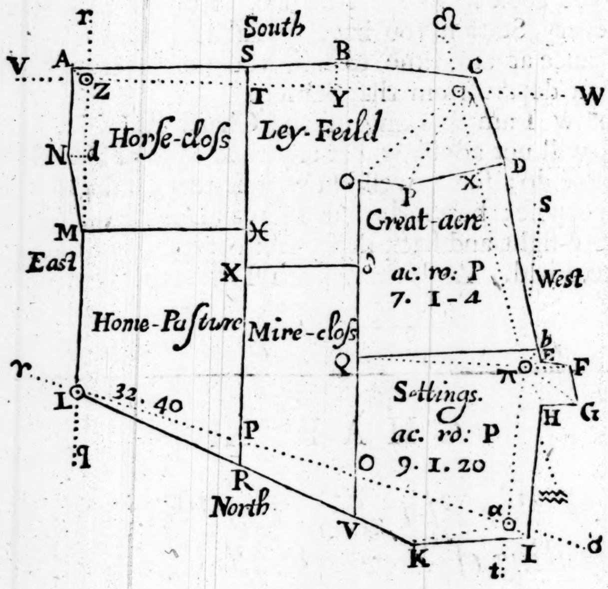
CHAP. XIV.

To take the Plot of a Lordship, or Mannor, Consisting of divers small Fields, Pastures, Wood-grounds and the like.

HAving in the former Chapters sufficiently taught how to Plot all manner of Grounds whatsoever, I shall not here particularly reiterate my former Demonstrations, and yet shall shew how you are to proceed about the same.

Suppose this Figure, or Diagram, be part of the Mannor of *Burton-Lazers*, near *Melton-Moubrey*, in the County of *Leicester*, which is to be Measured and Plotted. First therefore, according to the directions before delivered, after I have made choice of convenient Places for Beacons, as at α, π, λ, Z and L) I plant my Table at α, where having described the Angles I and K, I draw the line K I, then I direct the sights to π, to which I measure and there planting the Table I direct the sights severally to H,G,F, e, b and Q, and by the help of my Scale and Compasses I describe them, as hath formerly been shewed, drawing the lines, IH, HG, GF, Fe, e b and b Q. Next (the Table remaining fixed) I set my sights to λ, which I measure finding it

it 56 *p* 55; but as I come on to X 39 *p* 0, from π, I intersect the Hedge D P O in the point X, which I note with the point of my Compass. Again I plant my Table at λ, in such manner as hath been formerly taught, and describe the lines λ C, λ P, λ O, which I measure severally, and set them down from my Scale, drawing the lines E D, D C, D P, P O, then directing the sights from λ to Z, I measure the distance 71 *p* 60, which I prick down from λ to Z, and mark the point Z; but as I go on that line, when I come to Y, I take the depth of the Angle B 5 *p* 0, which I describe as in the Figure, drawing the line C B; and



likewise when I come to T, and intersect the Hedge T P, I make a mark there; and being arrived at Z, I plant my Table, where I rectifie the same in all respects, as is shewed in the former Chapters; which done, I describe the Angle A, then I set the sights to L, and measure the line, but coming to *d*, I describe the Angle N; and after I have measured 29 *p* 80, from Z, I touch the Hedge at M, where I make a Prick, drawing the lines A N, and N M. Afterwards measuring on to L 61 *p* 50, I describe the line M L, then I plant my Table at L, directing the sights back to Z, and the Table standing fixed, I lay the Index upon the line ♈ L α ♉, and if it cut the Beacon at α there is hope the Plot will close: next I measure on in the same line and when I come to P 32 *p* 40, from L, I make a mark drawing a line from P to S, (because the line is straight) in which line I measure from P to X, and find it 34 *p* 0, and from X to ♓ 9 *p* 60, which I describe drawing the line ♓ M, so is *Horse-Close* and *Home-Pasture* finished: Then I continue my measure forward

ward in the ſame line till I come to O 56 *p* 80, from my Station at L, and there making a mark, I draw the line O ♂ O; then I meaſure on in the ſame line to ♂ 41 *p* 10 and draw the line ♂ X, which done I perceive the whole work is finiſhed, and I have obtained the Plot of the whole Field, and every Ground contained therein. And if there had been more Grounds you ſhould have dealt in like manner with them, and proceed from one Cloſe to another till the whole be finiſhed: and if there be any Houſes and Homeſteds, you are to take them in and deſcribe them; as alſo all *Streets*, *Lanes*, *High-ways*, *Mills*, *Trees* and the like; but Practice, better than many Words, openeth this: Yet one thing in this manner of working I cannot omit, that when you come to take the Plot of a Town that is Spacious, (which commonly lies within the body of your Plot) you muſt proceed from *Street* to *Street*, and from *Lane* to *Lane*, deſcribing all the ſaid *Streets*, *Lanes*, *Houſes*, *Homeſteds*, and other edifices, which lie within your view as you go; and if you cannot conveniently go about them, then at Gates and other open Places, you muſt (from your main Stationary-line) make little inward Stations, in meet and convenient places, which you ſhall find very commodious in making a true Plot. But if you can paſs through back Lanes with your Table, and have the liberty to make fit Stations on the out-ſides, it will better ſerve your purpoſe, but I leave this to your own Conſideration, not doubting but that from what is already ſaid, you will be throughly enabled, not only to take the Plot of a Single Field, but alſo of a whole *Mannor*, whenever the ſame is required.

Having now ſhew'd you (with ſome brevity) after what manner you are to proceed about taking the Plot of leſs and greater quantities, and many ſeverals together, as a whole Lordſhip, or *Mannor*; and what courſe is moſt fitting in laying down and deſcribing the true proportion and ſymmetry thereof upon Paper (which I might have done after a far larger Method; but I ſhould then not only have been more tedious and Prolix, but alſo more obſcure and leſs profitable to my Reader:) and therefore it may ſuffice to give you onely the Plot of a part of a *Mannor*, by which you may by Inſpection, and the help of what hath been afore delivered; ſee the whole progreſs of my proceedings in doing the ſame and may thereby be able to do the like, as oft as occaſion ſhall require it: *See the Scheme in Chap.* 27 *of the following Appendix.*

CHAP. XV.

To take the Plot of a Field by the Degrees on the Frame of the Table.

WHereas in wet weather you cannot keep a ſheet of Paper upon your Table, it will be convenient in a few words, to ſhew you the way how to effect the ſame, by the Degrees on the frame of the Table. The uſe whereof is thus.

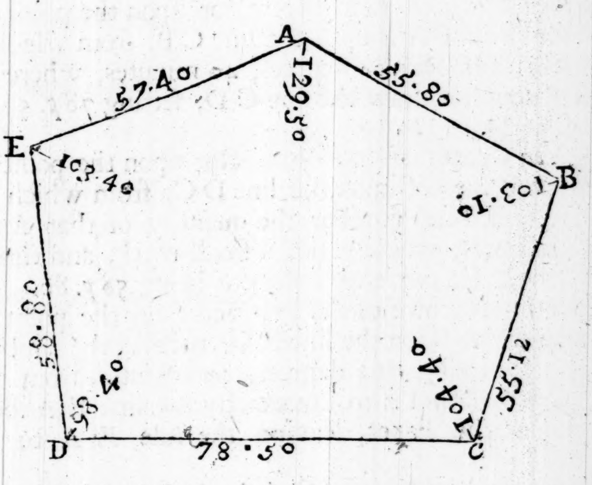
Place your Table at the Second Angle, and having Screwed it faſt, turn the Index about upon the Centre, till through the Sights you eſpie your Beacon erected at the firſt Angle, and Note the Degrees cut by your Index, upon the frame of the Table; then, turning your Index about, direct the Sights thereof to your Beacon ſet up at the Third Angle, and obſerve the Degrees there cut upon the Frame, and ſo by the difference of them you ſhall have the quantity of the Angle at your firſt Station: then meaſure the diſtance from the firſt Angle to your Station, which you are to note down in your Book, as alſo the quantity of the Angle before taken; next meaſure on to your ſecond Station (which is the third Angle) and there plant your Table as before, taking the quantity of the Angle there made and the Stationary diſtance, both which inſert in your Book, and ſo proceed from one Angle to another, till you have finiſhed the whole Field, taking the quantity of every Angle and all your Stationary-diſtances, as ſhall be more fully declared in the following example.

Let A B C D E be a Field to be meaſured, and being wet and moiſt weather, I cannot put a ſheet of Paper upon my Table; therefore, after I have ſet up my Beacons in every Angle of the Field, I firſt meaſure the ſide E A 57 *p* 40, and then I plant my Table at A, from whence I direct the ſights to E, and I find it cut upon the Frame at 30 Degrees 10 Minutes: next from A, I ſet the ſights to B, and find it to cut at 160 Degrees 0 minutes, the difference is 129 Degrees 50 Minutes, which is the quantity of the Angle at A, which I note in my Book, as alſo the ſide E A. This done, I meaſure on from A to B 55 *p* 80, and at B, I again plant my Table, where I find (according to the former directions) the quantity of the Angle 103 *D.* 10 *M.* which I ſet down in my Book, together with the ſide A B; and in this manner I proceed from Angle to Angle, and from Side to Side, till all is finiſhed: ſo in this Example will all the obſervations taken in my Book ſtand thus,

Angles.

		Gr.	*Min.*			*Per.*	*Pts.*
Angles :	A	129	50	Sides	A E	57	40
	B	103	10		A B	55	80
	C	104	40		B C	55	12
	D	98	40		C D	78	50
	E	103	40		D E	58	80
Sum.		540	00				

Now, that you may know whether or no you have taken all the Angles of the Field exactly; you are to collect the quantity of all the Angles found at your ſeveral obſervations into one Sum then multiply, the Semicircle, 180 degrees by a Number leſs by two than the number of Angles in the Field, and if the Factus hereof be equal to the total Sum of the Angles, then is your Work right and good, if otherwiſe, it is to be corrected.



Example. In the former Work the ſum of the Angles was found 540 Degrees 0. Minutes, and their number 5; therefore I multiply 180 by 3, (which is leſs by 2 than the number of the Angles) and the Product 540 degrees 0. minutes agreeing exactly with the Sum of all the Angles in the Field, it argues that the Work is exactly performed. The Geometrical ground hereof depends upon theſe two Propoſitions,

1. *In omni Triangulo tres Angli ſimul ſumpti, ſunt duobus Rectis æquales.* Euc. 1. 32. Ra. 6. 13.

In every Triangle, the ſum of the 3 Angles are equal unto 2 right Angles, according to our firſt Book and 17th Problem.

2. *Cujuſcunque Triangulati latera ſunt binario plura Triangulis à quibus conſtat.* Ra. 10. 2.

The ſides of a Triangulate are more by two than are the Tri-

 angles

angles of which it is made, as you may see in the eighteenth Problem of our first Book.

Note, That this Rule holds good when all the Angles of the Field are inward Angles, or less then 180 *d.* but if greater, you are to take their Complements, and then work as before.

Now having taken the quantity of all the Angles and Sides of your Field, I will here shew you how to Protract, and lay down the same upon Paper.

1. Therefore having drawn forth the line AB upon Paper, place the Centre of your Protractor upon the point A, and lay the Scale thereof upon the same, from which line (upon the Semicircle of your Protractor) set off the quantity of that Angle 129 degrees, 50 minutes, and draw forth the line A E, 57 *p.* 40, from your Scale, and the line A B 55 *p.* 80.

2. Lay the Centre of your Protractor upon the point B, and the Side thereof A F upon the line B A before described; and upon the Semicircle of your Protractor set off the Angle B 103 degrees, 10 minutes, drawing forth the line B C 55 *p.* 12, by your Scale and Compasses.

3. Lay the Centre of your Protractor upon the point C, and place the Side thereof A B upon the line C B, from which (upon the Semicircle) number 104 degrees, 40 minutes, where make a mark, and through it draw the line C D, setting 78 *p.* 50, thereon, from C to D.

4. Bring the Centre of your Protractor upon the point D, and set the Side A B thereof upon the line D C, from which (in the limb of the Semicircle) number the quantity of that Angle 98 degrees, 40 minutes, where make a small mark, and through it draw the line D E, the length thereof being 58 *p.* 80.

Lastly: Lay the Centre of the Protractor on the point E, and the Side thereof A B on the line E D, then in the limb of the Protractor, accounting 103 degrees, 40 minutes, from the said line E D, you shall find it to cut exactly the line E A formerly, described upon the Paper, leaving the side E A to contain 57 *p.* 40.

Thus have you now protracted the said Field, according to the observations you made by the degrees on the Frame of your Table: But you shall find that Practice, better than many words, will make this apparent; however this manner of working, as it is more troublesome and difficult than any of the former ways before described, so may the Surveyor be sooner mistaken in it, than in any of the rest; and therefore, as I have plac'd it last in order, so I would never have my Surveyor use it, but when necessity compels him, as in wet and stormy Weather; and the rather, because it takes up more time and labour than ordinary, to little purpose; but I leave it to the consideration of the Reader, to whom (I hope) I have given abundant satisfaction in the preceding Chapters.

CHAP.

CHAP. XVI.

Of the Measuring of Hills and Dales, with the best way of Plotting thereof.

FIrst take the Plot thereof by the Perimeter, according to the 13 Chapter, and resolve it into the greatest Trapezium that the Plot will bear, then let fall Perpendiculars to the Base; which done, go into the Field, and measure with your Chain those lines which represent the Base and Perpendiculars, which you shall find longer than those lines in the Plot, and cast up the Plot by those Numbers, not by those lines, and you shall have, not only a true Plot thereof, but also the just quantity and content, as the ground is unlevel. Other ways I could shew you, but being troublesom and not so exact as this, I will at this time omit them.

CHAP. XVII.

To find the just quantity, or content, of any piece of Ground.

ALthough in the third Book I have shewed how to measure the superficies of any regular Figure whatsoever, as the Geometrical-square, Parallelogram, the Triangle, Trapezium, the Circle, and the like; and also how to measure any irregular Figure; yet I hold it necessary to adjoyn one Example more, which will illustrat the use thereof more fully.

Suppose this Figure A B C DEFG, be the Plot of a Field, drawn upon the Table by a Scale of 32 in an Inch, and the exact content thereof is required.

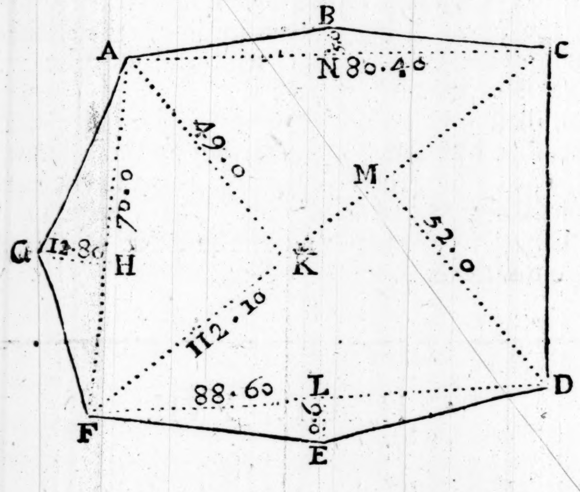
Now, because it is an irregular Plot, lying neither in the Form of a Square, Parallelogram, Trapezium, nor Triangle; therefore it must be reduced into some of these forms; which to effect, I first reduce the main body of the Field into the Trapezium A C D F, and the residue of it into three Triangles, as A B C, D E F, and A F G.

Then to know the just quantity of Acres the Field contains, I first measure the Trapezium A C D F, to which end I take the length of the Perpendicular D M from my Scale 52 *p* 0, and the length of the perpendicular A K 49 *p.* 0, which I add together, and

and they make 101 *p*. 0, which I multiply in half the Base C F 56 *p* 05, and the Product 5661 *p*, 05 is the Content of the Trapezium A C D F.

In like manner for the Triangle A B C, I multiply half the Base 40.20 by the Perpendicular B N 5 *p* 0, and the Product is the content of the Triangle A B C 201 *p* 00.

So, for the Triangle A G F, I multiply half the Base 35 *p* 00, by the Perpendicular G H 12 *p* 80, and the Product 448 *p* 00, is the Content of the Triangle.



Likewise, in the Triangle D E F, the Base D F is 88 *p* 60, and the Perpendicular E L 9 *p*. 0, therefore I multiply the half Base 44 *p*. 30 by the Perpendicular 9 *p*. 0; and the Factus 398 *p*. 70, is the Area, or content of the Triangle D E F.

Lastly, I add the several Sums together, and they give the Content of the whole Figure.

The Area, or Content of the	Trapezium	A C D F	5661. 05
	Triangle	A B C	201. 00
	Triangle	A G F	448. 00
	Triangle	D E F	398. 70
The Area or Content of the whole Field.			6708. 75

Which being reduced into Acres, yieldeth the Content of the said Field 41 Acres 3 Roods, 28 Perches, and three quarters of a Perch.

After this manner you may cast up the content of any irregular Field, by reducing it into Trapezias and Triangles and adding their several Products into one Sum, which ought heedfully to be regarded, as being one of the most material Things belonging to the Practice of the Surveyor; for unless he be perfect

fect herein, he can never perform any Work of that nature aright.

CHAP. XVIII.

To reduce Perches into Acres, & contra.

According to the Statute of 33 *Ed.* 1. *De terris mensurandis, & de compositione Ulnarum & Perticarum*, it is ordained, *That 3 grains of Barley, dry and round, do make an Inch*; 12 *Inches do make a Foot*; 3 *Feet do make a Yard*; 5 *Yards and half do make a Perch*; *and* 40 *Perches in length, and four in breadth, do make an Acre.* So that 16 Feet and a half, square, is a Perch, according to the Statute, and 160 of these Perches make an Acre; when therefore you are to reduce any number of Perches given into Acres, you must divide the number given by 160 (which are the number of Perches, contained in one Acre) and the Quotient will shew how many Acres are therein; and if any Perches remain after your Division, and that Number exceed 40, divide again by 40, and the Quotient will shew the Roods, and the remainder the Perches: Example, Suppose you were to turn 547*p* into Acres, therefore first I divide 547 by 160, and the Quotient will be 3, and 67 remaining, which divide by 40, the Quotus will be 1, and 27 remaining; So that it amounteth to 3 Acres, 1 Rood, and 27 Perches.

Again if you would reduce 6708 Perches into Acres: Divide (as before) by 160, and the Quotient will be 41; and 148 remaining, which 148 being divided by 40, the Quotient will be 3, and 28 remaining, so that the true quantity in Acres will be 41 *Ac.* 3 *R.* 21 *P.*

But you may with more celerity reduce your Perches into Acres, if you cut off the first figure of your Sum toward the Right-hand, and then divide the sum remaining by 4, and the work will stand thus:

In this Paradigm, the 167 are so many Roods, and 28 Perches remaining.	2 67018 167
Then in like manner divide 167 by 4. and the Quotient is 41, and 2 remaining; so will the sum of the Perches given contain, 41 Acres, 3 Roods, and 28 Pole.	3 167 4 41. 3. 28

CHAP.

CHAP. XIX.

To reduce Statute-measure to Customary measure, and the contrary.

ALtho an Acre of Land, according to the aforesaid Statute of 33. *Edward the First*, is to contain 160 square Perches, of 16 Feet and half to the Perch; yet in regard that in some places of the Nation, through long custom, there is at this day other Perches used, as 18, 20, 24 and 28 Feet to the Perch; it is therefore necessary to shew my Surveyor how he may readily reduce the Statute-measure into Customary, *&c.*

Suppose therefore you would reduce Statute-measure to Woodland-measure, of 18 Feet in the Perch, then say.

As the square of the greater Perch of 18 *Feet, it to the square of the lesser Perch of* 16 *Feet and a half: So is the content in Acres according to the lesser Perch, to the content in Acres, according to the greater Perch.*

Let it therefore be required to reduce 36 *Ac.* 2 *R.* 10 *P.* at 16 Feet and half to the Perch, into Woodland-measure of 18 Foot-Perch. *First*, You must observe that the square of 16 Feet and a half is decimally 272, 25, and the square of 18 feet is 324; then I reduce the said 36 *Ac.* 2 *R.* 10 *P.* into Perches, which make 5850, then I multiply the same by the square of the lesser Perch 272. 25, and the Product 1592662.50 being divided by the square of the greater perch 324, the Quotus is 4915.625.

Otherwise, You may find out the least proportional terms between 18 and $16\frac{1}{2}$, which by their abbreviation by $1\frac{1}{2}$, you shall find to be 12 and 11; then square these two sums 12 and 11, which produceth 144 and 121, which done, Reduce your 36 *Ac.* 2 *R.* 10 *P.* into Perches and they make 5850, as before, then multiply the square of 11, which is 121, by 5850, and it produceth 707850, which I divide by 144, and the Quotus is $4915,\frac{5}{8}$, which reduced into Acres, is 30 *Ac.* 2 *R.* 35 $P,\frac{5}{8}$.

But, suppose you would reduce Woodland-measure into Statute measure, then say.

As the square of the lesser Perch of 16 *Feet and half, is to the square of the greater Perch of* 18 *Feet: so is the content in Acres, according to the greater Perch to the content in Acres, according to the lesser Perch.*

As in the former Example, I multiply the 4915*p.*625, given according to Woodland-measure, by 144, the greater square, and the Product is 707850. 00, which, divided by the lesser square 121, the quotient is 5850. Perches, which, reduced into Acres, is 36 *A.* 2*R.* 10 *P.*

This

This courſe is to be obſerved in all reſpects in the reduction of other quantities, of what proportion ſoever, as thoſe of 12, 20, 24, and 28 Feet in the Perch; and thus much briefly for the Reduction of Statute meaſure into Cuſtomary, and the contrary.

CHAP. XX.

Shewing the beſt way of meaſuring the ſeveral and particular quantities of Arable-Land, Leys, and Medows, lying in the open or common Fields: With ſhort directions for the taking in, and incloſing a Lordſhip.

FOraſmuch as this preſent Age hath ſo highly affected Incloſure, that a very great quantity of Land in the Nation is now reduced to that kind of quality, which before lay open, and in common; and ſeeing more is daily going in, and much more like to follow, it may therefore be expected, that I ſhould give ſome directions about that matter, and ſhew what courſe is moſt requiſite to take in the proſecution thereof. When therefore the Surveyor is to proceed about the Survey of a Lordſhip, or Mannor, wherein the Lord and Freeholders are agreed to improve it, in laying each Man's Land together, in ſeveral by it ſelf (which in all common Fields lies diſperſed, in many ſmall parcels), it will be convenient to begin at one ſide of the Field, and there ſet down the Name of your firſt Furlong, in your Field-Book, and upon what point of the Compaſs you begin. And to the end you may the better expreſs the juſt length, breadth, and quantity of each Part and Parcel of every Man's Land, as it ſhall riſe in order; it will be neceſſary to provide a Book, of a quire of Paper, at the leaſt, wherein each Page is to be divided into 6 Columns, ſo as the two firſt towards the Left-hand ſhall ſerve for the breadth of the Lands at each end: the third, or greater Column, ſhall contain the butting, bounding, and Number of every Man's particular Lands, Leys, Doles of Meadow, or the like; and the fourth, fifth, and ſixth, for the reduced breadth, length, and quantity.

Next after you have thus done, and are come to the Furlong where you begin, expreſs in your Book the Name of the Field, and particularly of that Furlong; then, in the Middle-

most, or greater Column, put down the Name of the Freeholder that first begins it, with the number of his Lands; against which, in the two first Columns toward the left-hand, write the breadth of the Lands at each end, and in the three last put the reduced breadth, length, and quantity; which done, set down the Name of the Freeholder that lies next, and the number of his Lands, together with the breadth, length, and quantity, as before. Afterwards set down him that riseth next, with his particular breadth, length, and quantity, and so proceed in order, till you have finished the Furlong.

Having compleatly finished one Furlong, go on to the next, where you are to write the Name thereof, and upon what Point you enter, and then set up the particular quantities of Ground belonging to each Land-holder, as they rise in order, till you have finished the same, as was before declared; afterwards go on to the third Furlong, and do the like there, and so on, from one Furlong to another, till you have finished the whole Field.

But that you may more fully understand the perfect Form and manner thereof, I shall (with much brevity) shew you in the following Example an absolute Method, how you may speedily effect the same.

The Form of the Field-Book.

North-*Luffenham*, *Com. Rutland.*

Oldham's-Hedge Furlong, beginning West, at the way leading to *Edith-Weston.*

5	7	4	15	*Sam. Hunt* 2 Lands	5	1	28	0	141	40
6	6	6	0	*Jonathan Barker* 3 l.	6	3	28	0	172	20
8	18	8	14	*Sam. Hunt* 5 lands	8	16	28	4	248	16
1	5	1	13	*Vincent Wing* 1 land	1	14	28	6	48	11
24	0	23	8	The *Beadhouse* piece	23	14	28	10	675	45
1	9	1	7	*Tho. Freeman* 1 land	1	8	28	12	40	04
2	16	2	12	*John Weaver* 2 lands	2	14	28	12	77	22
1	16	1	14	*Vincent Wing* 1 land	1	15	30	10	53	37
4	16	4	12	The *Town* 3 lands	4	14	30	18	145	23
1	0	1	0	*John Weaver* 1 land	1	0	31	6	31	30
1	4	1	2	The *Town* 1 land	1	3	32	0	36	80

The

The ſecond Furlong begining Weſt.

17	17	17	5	L. *Camden* 11 Lands	17	11	37	10	658	12
1	18	1	6	*Parſonage* 1 land	1	17	34	18	64	56
1	14	1	12	*Vincent Wing* 1 land	1	13	34	10	56	92
2	12	2	10	The *Town* 2 lands	2	11	34	10	87	97
1	11	1	11	L. *Camden* 1 land	1	11	34	10	53	47
1	10	1	8	*Tho. Freeman* 1 land	1	9	34	8	49	88

The *Beck*-Furlong begins Weſt, at *Brokenback*.

1	19	1	17	*Jonath. Barker* 1 Ley	1	18	32	12	61	94
2	0	1	18	*Vincent Wing* 1 ley	1	19	32	12	63	57
6	16	4	0	*James Digby* Eſq; 3 ley	5	8	33	17	182	79
8	17	4	3	*Jonath. Bar.* a piece	6	10	28	0	182	00
3	16	3	12	The *Town* 3 leys	3	14	26	12	98	42
1	14	1	12	*Vincent Wing* 1 ley	1	13	24	10	40	42

After this manner you are to proceed, from one Furlong to another, until you have finiſhed your Field-Book; which being done, you are next to make a particular of every Mans Arable, Leys, and Meadow, ſeverally, to which purpoſe, upon a fair ſheet of Paper, you are to make ſo many Columns, as there are Freeholders, every one whereof is to be ſubdivided into three, ſo will the firſt ſerve for Arable, the ſecond for Ley-ground, and the third and laſt for Meadow, if there be any: and if one ſheet will not contain the whole, then may you take two or three, or ſo many as you ſee convenient. Then, turning to the Field-Book, I begin upon *Oldhams*-hedge Furlong, with 2 lands of Mr. *Samuel Hunts*, and write in the Particular, in its proper Column, under Arable, 141 *p.* 40: then Mr. *Jonathan Barker* 3 lands 172 *p.* 20: next Mr. *Samuel Hunt* 5 lands, 248 *p.* 16, which I place likewiſe under their Names, and in their due Place, and ſo I proceed till I have finiſhed the Book; placing every Mans Arable land, Leys, and Meadow, in due order; which being performed, then make your *ſumma totalis*, as is done in the following Synopſis.

A Particular of all the Arable, Leys, and Meadow-ground, in the Lordship of N. Luffenham, Com. Rutland.

Samuel Hunt.		Jonathan Barker.		Vincent Wing.		Bead-house.		Thomas Freeman.	
Arable.	Leys.	Arable.	Leys.	Arable.	Leys.	Arable.	Leys.	Arable.	Leys.
141 40		172 20	61 94	48 11	63 57	675 45		40 04	
248 16			182 00	53 37	40 42			49 88	
				56 92					
389 56		172 20	243 94	158 40	103 09	675 45		89 92	

John Weaver.		The Town.		Lord Camden.		Parsonage.		James Digby, Esq;	
Arable.	Leys.	Arable.	Leys.	Arable.	Leys.	Arable.	Leys.	Arable.	Leys.
77 22		145 23	98 42	658 12		64 56			182 79
31 30		36 80		53 47					
		87 97							
108 52		270 00	98 42	711 59		64 56			182 79

After this manner, you are to make a Particular of the whole Field, and not make your *Summa totalis*, till all your Furlongs be inserted in the Particular: But this is a perfect Example, according to which you may effect the whole.

The next thing you are to do, is to take the Plot and general Survey of the whole Lordship; according to the manner delivered in the former Chapters, and see if the sum of all the particulars agree with the Total. Then you may conclude the Work is exact, but most commonly the Particulars (if they be exactly taken) will somewhat exceed the general Survey, especially where the lands lie high, as in *Leicestershire*; and in this case, that both may agree, you are to reduce the sum of every Mans Particulars, answerable to the Proportion of his Ground, which may speedily be effected by the Golden-Rule: For, if in the whole Field (which admit it be 1200 Acres) the Particulars exceed the general Survey 3 *Ac.* or 480 *P.* what shall 20 *Ac.* exceed? the Answer will be 8 *P.* and so much I am to deduct out of the sum total of such a Mans Particulars, according to which I am to Plot him 19 *Ac.* 3 *R.* 32 *P.* as is directed in the sixth Book: But before I proceed to set out any Plots in the Field, it is usual, in most places, for the Freeholders to choose Commissioners, who shall appoint in what part of the Fields every Mans Plot of Land shall lie, where you are exactly to measure and lay out the same, according to the quantity in your Particular. And lastly, when all the Plots are set out, and corrected, if need be, you are (as often as it shall be required) to draw a Plot of the Town, Streets, Lanes, Houses, Homesteds, Woods, and all the old and new Inclosure; not forgetting to describe every River, Gutter, Water-course, and Mills, if any be, as also Trees

Trees, where they are ſtanding, and that partly according to their number and quantity. Laſtly, when you have drawn your whole Work upon Paper, you may ſpeedily draw out the ſame upon Vellom, or Parchment, which being garniſhed with Water Colours of the beſt ſort, will neatly ſhew the juſt proportion and Symmetry of the whole Mannor. But if you know not the way how to do it, then take theſe ſhort directions.

Rub the Backſide of your Paper-plot, all over, with Black-lead, or Sallow-cole, then lay your skin of Vellom upon a ſmooth Table, and upon that lay the leaded ſide of your rough Plot, which you are to faſten upon the Vellom, at the corners, with Mouth-glew, then take a Bodkin, and therewith gently trace over all the lines within the ſaid Plot, and whatſoever elſe you would expreſs, then taking off the rough Plot, you ſhall ſee upon the Vellom, the perfect Draught of your whole Work, which you may beautifie at pleaſure, with neat Colours.

Before I conclude this Chapter, I ſhall ſpeak ſomething concerning Incloſure, by way of Caveat and advice, to all ſuch as proceed that way. And firſt I ſay, that the laying of mens Land together in Plots, and Incloſing the ſame, is a thing, as I conceive, that in it ſelf is very good and profitable, provided it be ſo performed, that there may be ſufficient Proviſion made for the Poor, and no depopulation enſue. But we ſee the contrary in many Places, and eſpecially where a Lordſhip lies in the hands of two or three men, and then what follows (in ſuch places) but depopulation, for nothing (many times) will be allowed the Poor Tenant, no not upon indifferent Rents, but the Lord of the Mannor (in moſt places I have ſeen) preſently ſets all his land upon a Rack-rent, and if ſome allowance be made to the Poor Cottiers, at a little cheaper rate than ordinary, yet no ſooner but when one Man dies the land is taken from the houſe, and the houſe is immediately pulled down, and ſo at length many a Town is depopulated and comes to nothing, and there is no Inhabitant left in the place, but, as our common Proverb hath it, the Shepherd and his Dog, whereas before it would contain two or three hundred People, to live upon in good ſort and faſhion. But let us obſerve what follows theſe Depopulators; doth not the Curſe of God purſue them, to the Heels? How many great ones of this Nation, after they have effected their evil deſigns, in depopulating whole Lordſhips, have been ſuddenly taken away by Death? Others, tho' they have raiſed their Eſtates, yet preſently come to nothing, whereby we ſee that of the Prophet verify'd. *Væ vobis, qui conjungitis domum ad domum:* wo to them that joyn houſe to houſe, and lay land to land, till there be no place left for the Poor. And the wiſe man tells them *Prov.* 22. 16. *Qui opprimit tenuem, ut amplificet rem ſuam, & qui dat diviti, tantum ad egeſtatem deveniet.* And ſure I am, that the depopulation is a great Sin, and highly provoking the Lord to wrath. Let me therefore admoniſh all (that go upon deſigns of this nature) to be careful to make

ſuch

ſuch proviſion, that the Inhabitants of every Town and Village, where Incloſures are made, may have ſuch quantities of Land laid to their particular houſes, to be aſſured to them, and ſuch as ſhall ſucceed them, for ever, and that ſuch Proviſion and good orders may be taken, that Gods Bleſſing may follow upon their juſt deſigns and undertakings. But I would not have you think that I here ſpeak againſt Incloſure in the leaſt, but only againſt depopulation, for I have ſeen, and do daily ſee, much Inconveniency in many open and common Fields, where (Land lying intermixt) one Man continually intrenches upon another, by plowing, and in their Common, and ſo it may do well in ſuch places, eſpecially where all the Town are Freeholders, in which caſe, their Land being laid out in ſeveral Parts, and incloſed by it ſelf, all the Inhabitants may the more fitly and commodiouſly enjoy their own, and not be ſubject, ſo continually, to treſpaſs upon one another, as is uſual in common Fields. And beſides it would be a thing very good for all ſuch People, who have much Tillage, and little or no Paſture, to lay down ſome of their Land-Ground; and convert it into Paſture, whereby keeping a greater ſtock of Cattel, they may be the better enabled to uphold their Tillage, which would be an enriching to them, as I have ſeen it verify'd in ſundry Places of this Nation, where by good Manuring thereof, they find more profit of one Acre, then they did of two before, and beſides (keeping more Stock and better Dairys) they are better enabled to maintain their Families. And ſurely if the Incloſure be no more, but for the better management and upholding of Tillage, it cannot be offenſive to the word of God, or deſtructive to the outward well-being of mankind, but will tend much to the good and welfare of the Nation. And thus much briefly touching Incloſure.

The End of the Fourth Book.

AN

AN APPENDIX TO THE Art of Surveying,

Demonstrated by a New Instrument, CALLED

The EMPERIAL TABLE.

WITH A

New Scale and *Chain* fitted thereto; performing exactly, and in all Respects, the Work of the *Plain Table*, *Theodolite*, *Circumferentor*, *Peractor*, *Chard* and *Needle*.

BEING

The only Instrument yet made Publick; which is also carefully and exactly adjusted to all the Cases that possibly can happen

IN THE

PRACTICAL PART OF SURVEYING.

Illustrated in a more *Plain* and *Practicable* Method than any hitherto Invented.

By *JOHN WING*, Math.

Pro captu Lectoris habent sua fata Libelli.

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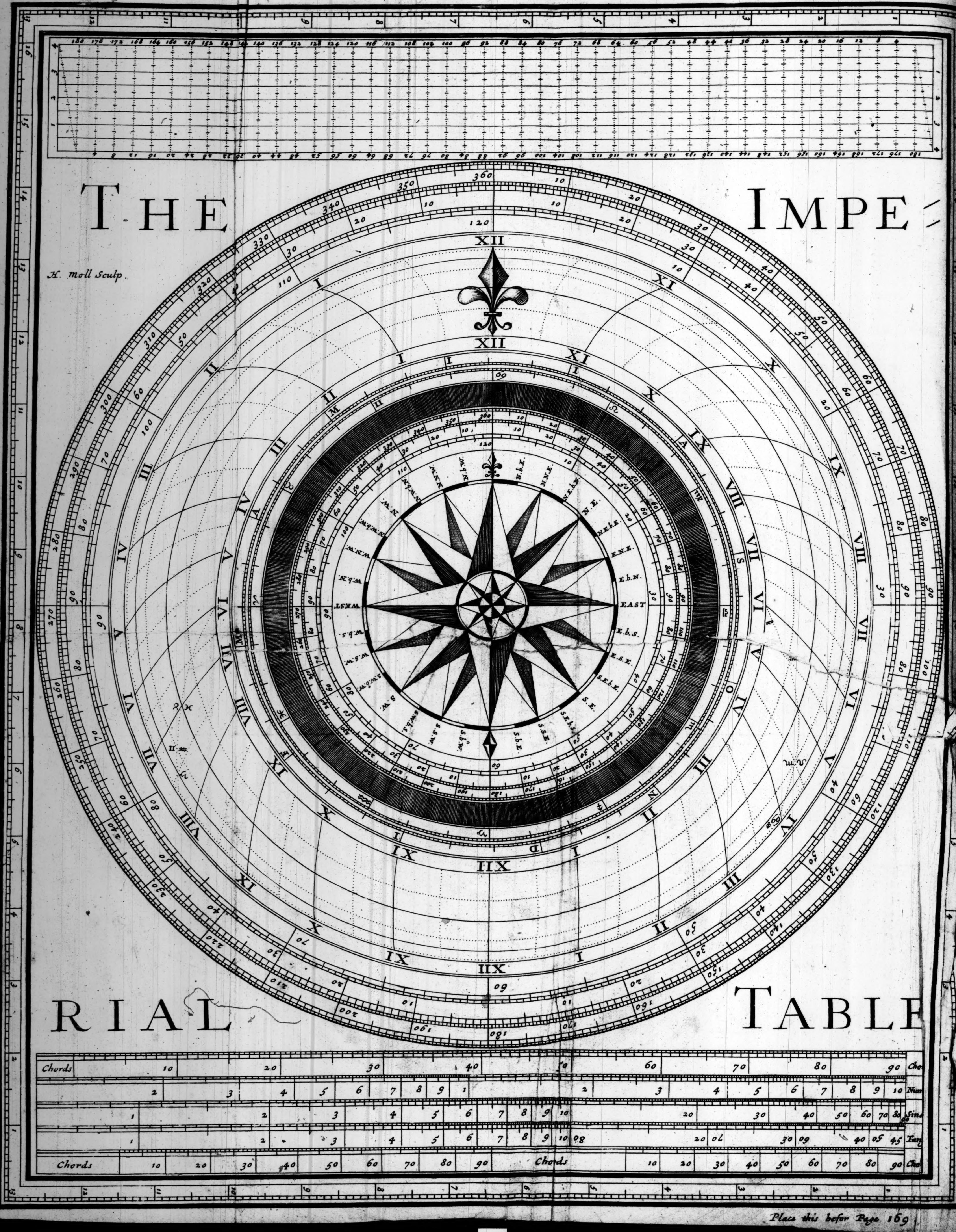

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AN APPENDIX.

CHAP. I.

The Reasons and Inducements of the Authors Publication.

HAving ſpent many penſive thoughts about finding out ſome Inſtrument in Surveying, that might be truly Subſervient in all the Variety of Caſes, that may poſſibly happen in the Practical part of Surveying, which took me up ſome time in the conſideration thereof, and the Reaſons that induced me to it, was no other than (in my apprehenſion) the great want I found of ſuch an one: And had not my Experience been equivalent to my Apprehenſion, I am really Induced to believe, I had not been ſo ſenſible of the want thereof, nor ſo happy as to have ſet about it, and tho' the Plain Table as Mr. *Lybourn* directs; comes neareſt the matter in hand, yet 'tis very inſufficient and defective in the Performance, (in ſeveral Caſes) of the Work of the Theodolite, Circumferenter, and Peractor, and the Declinatory-Azimuth, or Needle, which Inſtruments in their proper places (if well underſtood) will perform what ever is, or may be required in the Practice of Surveying: Yet not any one of theſe is ſufficient to be confided in, for all Caſes that may happen in Surveying, as the experienced and well grounded Surveyor, muſt needs acknowledge; neither would I here be thought to condemn any of them, as Firſt, being compoſed by able Artiſts, and Secondly, are all of good uſe in Surveying, tho' not generally for all Caſes that may happen, as hereafter more fully will appear.

Now the Inſtrument I here inſiſt on, I call the EMPERIAL TABLE, as being a perfect Plain Table, an exact Theodolite and Circumferenter, and the Peractor exactly adjuſted, the Needle or Declinatory alſo fully Compleated thereon, in its own kind and order, which Inſtruments are all here fully compleated upon this one Inſtrument, without the leaſt confuſion of Lines or Parts. As will readily appear by the ſubſequent diſcourſe.

CHAP. II.

The Description and Use of the Chain.

I. *A Description of the Chain.*

IT has been no hard matter amongst our late Authors, to fix upon what Chain is the best and readiest in Practice, which is that of Mr. *Gunter*'s Composing, consisting of 25 Links in a Pole, and the whole Chain containing 4 Poles or 100 Links, answering to Decimal Arithmetick. But the Chain which I make use of, and do here recommend as exact and Practicable as any, and in some cases better than any, is that of 20 Links in a Pole, and the whole Chain consisting of 4 Poles or 80 Links, which is applicable to Decimal Arithmetick, as well as any other Chain whatever, and more Essential to our purpose in Practice, if used with that Scale I have Composed proper to the Division thereof, as in the next Chapter more fully may appear; and by the several Examples in the following Part, to which I shall premise these following considerations, *Viz.* that of all the Methods I have yet observed (and those not a few) from all Authors, I have found none so Intelligible, Plain and Practicable (in my Opinion) as what I here deliver.

II. *The Use of the Chain.*

To prove this a DecimalChain, and how to apply it to Decimal Arithmetick, I proceed thus, *Viz.* In taking the Dimensions, let it be done in Poles and Links, and accounting every two Links (that is for the odd Links over and above the number of Perches given) one Prime, and every odd Link 5 Seconds, always distinguishing these Fractions, or Decimal Parts of a Pole, by a Prick between the Poles, or Integers, and the Primes and Seconds, or Decimal parts of a Pole. As suppose 20 Poles, 10 Links, where given, place them thus, 20. 5, that is 20 Poles and 5 Primes. Again suppose a Length given to be 45 Poles 19 Links, write them down thus, 45. 95, that is 45 Poles, 9 Primes, and 5 Seconds, then for the Method, or way of resolving, or casting up any two Summs or Numbers given into a Product, observe to Multiply the given Numbers (in the order before-nam'd) as whole Numbers, cutting off so many figures of the Product towards the Right-hand, as there are Fractions or Decimal Parts in both Numbers; so will the Figures on the Left-hand be Perches, and those on the Right-hand the prick or stroak, parts of a Perch.

EXAM.

EXAMPLE.

Let it be required to Multiply 56 Pole, 15 Links, by 41 Pole 7 Links, being the length of two lines given, place them as above directed, and work them as in this Example, so will your Product be found (cutting off 4 figures towards the Right-hand, being the Number of Fractions in both Numbers) 2346 Perches and $\frac{6125}{10000}$ parts of a Perch, beng above half a Perch more: Again take these two following Examples more to make all Plain.

56.75
41.35
28375
17025
5675
22700
2346.6125

II. EXAMPLE.

Admit 25 Pole 6 Links, were given to be Multiplyed by 16 Pole 12 Links, as also if 45 Pole 18 Links given to be Multiplied by 12 Pole 15 Links, each Product will be found as following, *Viz.* the first is 419 Perches $\frac{98}{100}$, the second 585 Perches $\frac{225}{1000}$.

25.3	12.75
16.6	45.9
1518	11475
1518	6375
253	5100
419.98	585.225

These being all the Cases that can happen in the use of the Chain, *viz.* in taking the Dimensions in Poles and Links, being thus ordered and disposed.

CHAP. III.

The Description and use of a New Decimal Scale, exactly fitted to the Division of the former Chain.

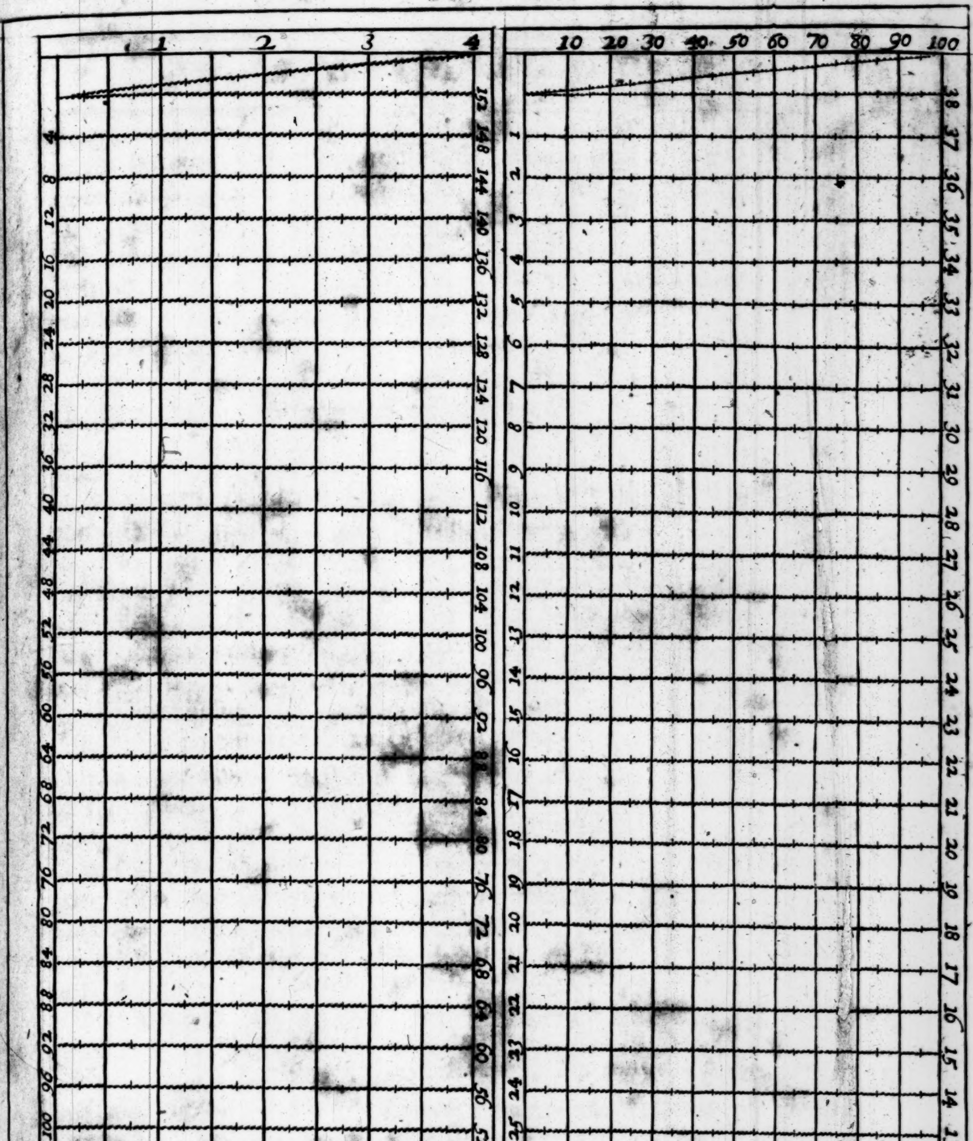
VEry few (or indeed any) Authors writing upon this Subject have afforded us Scales proper to the Division of the several Chains they have treated of, so that those who knew no better (nor other) were forced to content themselves with the Vulgar Scales of equal parts, which could never be used otherways, than by halves, quarters, &c. of a Perch; so that Decimal-Arithmetick was wholy laid aside as useless in the use of these Scales, which all or most Authors have so extreamly cryed up, which indeed can never be too well spoke of, tho' in this Case it never before had a fit Object for its application, save

what Mr. *Wybeard* has done in my Uncle *Wing*'s *Geodætes Practicus* for *Gunter*'s and *Rathbourn*'s Chain, which animated me to consider of such a like Scale, for this Chain I here recommend, and because the Chain consists of 80 Links, so will the Divisions on the Scale be more perceptible, freer from confusion, and more Practicable, for every Pole and Link may be very compendiously protracted from this Scale without the least Confusion or mistake, as will appear by its description and use following.

The description and Explanation.

First, the Scale is adjusted to a Scale of 16 parts in an Inch, as being the most usual in Practice, so that every quarter of an Inch, is equal to 4 Poles in length, or one Chain, which may be graduated on the Rular as far as the extent of a pair of middle-sized Compasses will extend, and numbering every such division down the side by 4, 8, 12, 16, 20, &c. being called the Perch-line, and it will be convenient to have the breadth of the Scale $2\frac{1}{4}$ Inches, and the length 21 Inches at least, that, when the Sights are placed upon it, may be of convenient length to fit the Table, and to be used as an Index as well as a Scale; and here Note by the way, that the Sights do not slide on the Rular, as they are now commonly made, but are to be fastned to the Rular with Brass-pins and Screws, so that they may be fitted upon either side of the Rular, for the Rular being graduated with the common Diagonal-Scale, by the side of which may be placed Scales of equal parts, as 12, 16, 24, &c. on the one side with a Scale of Chords, and with this New Decimal Scale on the other side, so that either side may be used, according to the will, Capacity, or Apprehension of the Artist. But to return to the Division of our Decimal Scale, the Division of the Side-line numbered and divided as before, I call the Pole or Perch-line, now in regard the Chain is 4 Poles long, the breadth of the Rular must be divided into 4 equal parts, and Lines drawn the proposed length, and Parallel to the side, and numbred on the Top with 1, 2, 3, 4, representing 4 Poles the length of the Chain, and if each of those divisions be divided into two equal parts, and lines drawn Parallel to the former, they will divide the Perch into two equal Parts, $\frac{1}{2}$ Poles, or 10 Links: Then each of those divisions divided in the middle by a small stroak representing $\frac{1}{4}$ of a Pole or 5 Links, and the intermediate Pricks represent each Link of the Chain, for there will appear to be 20 pricks and Divisions betwixt one Pole and another, and the whole breadth of the Chain thus divided into 80 equal Parts, being the number of Links contain'd in the whole Chain.

The Transvers-line on the Top extended from 0 to 4, is call'd the Link-line, and divided in all respects as the other overthwart lines are, that are drawn Parallel to the Top, and their distance $\frac{1}{4}$ of an Inch, through the limited length of the Rular, and to make the Index more useful and commodious, draw and divide another



Place this between P.172 & 173

another Transvers, or Link-line at the other end, and number the Divisions down the other side, and on the Top, as the other end and side directs, so will the Index be compleated for use which Side soever is towards you, but to make all Plain: I have here drawn the true Figure of the Scale as followeth.

The way of using the Scale.

Little need be said about directing how to use this Scale, if the former description and directions be rightly understood, but to cleer the Point more fully, take these two following Examples.

Suppose I were to take from this Scale 38 Pole 15 Links, find the next lesser number on the side in the Pole-line, *viz.* 36, placing one Foot of the Compasses there and tracing that Foot along that line, as far as 2 Pole 15 Links (as the figure on the top of the Scale directs) extends, as the Divisions Plainly shew, that Foot resting there, extend the other in the same Parallel and division in the Link-line, which extent is the distance required to be taken from the Scale, *viz.* 38 Pole 15 Links.

Contrarily, if 38 Pole 15 Links, were a Length given to find its quantity upon the Scale, first try the length upon the Scale, to see what number it will fit in the Pole-line, to fall somwhere in the Link-line, which again is 36, so Tracing one foot of the Compasses (opened to the said extent) along that Line, till the other foot of the Compasses fall on the same Parallel in the Link-line, which will fall in 2 Poles (as the top-figure directs) 15 Links, which makes the 38 Pole 15 Links the thing required.

☞ Here *Note* that the Dimensions may be taken from this Scale in Chains and Links, as well as Poles and Links, for every division down the Pole-line is one Chain, and the Link-line being divided into 80 Parts equally, being the number of Links contain'd in one Chain, hence accounting the figure 1 on the top to be 20 Links, 2 to be 40, 3 to be 60, and 4 to be 80, it will then appear to the same purpose as the former way of dividing it.

CHAP. VI.

The Description and use of Mr. Gunter's *Chain, and a Scale proper to the Division thereof.*

AS for these Surveyors that are Wedded to Mr *Gunter's* Chain, and do resolve to use no other, for their Sakes I have added the Scale proper to the Division thereof, to be placed on

on the other side the Index instead of the Scales of equal parts, the figure of which Scale is here placed by the side of the other Decimal Scale, which is to be used by Chains and Links, which need not be further Explained, if the use of the former be well understood, for Mr. *Gunter*'s Chain of Four Poles length consists of 100 Links which is 25 Links in a Pole, so is it to be used in taking dimensions, *viz.* in Chains and Links, and not in Poles and Links as the former, hence the Chain-line down the side is numbered by 1, 2, 3, 4, 5, Chains &c. and the Link-line on the top by 10, 20, 30, &c. to 100 being the number of Links in the Chain.

The way of Casting up by Mr. Gunter'*s Chain.*

The way of casting up the contents of any Dimensions taken by Mr. *Gunter*'s Chain, is to multiply the Chains and Links together and cutting off 5 figures towards the Right-hand, the Remainder on the Left-hand will be Acres, then those figures cut off towards the Right-hand, multiply by 4, and from that Product also cut off 5 figures as before; so will the Figure on the Left-hand be Roods. Again, Multiply the remainder last cut off by 40, cutting off from this Product also 5 figures to the Right-hand, so will the figures on the Left-hand be Perches, so will the Content by multiplication only be given in Acres, Roods, and Perches.

EXAMPLE.

Suppose a piece of Land lying in the form of an Oblong whose length is 10 Chains 50 Links, and its Breadth 5 Chains 25 Links, which multiplyed together, produceth 551250, from whence if 5 figures be cut off as before, there remains 5 Acres, and 51250 parts of 100000 of an Acre, which multiply by 4, so is the Product 205000, from which cutting off 5 figures as before, leaves 2 Roods and 05000 parts of 100000 of a Rood, which multiply by 40, the Product is 200000, from which cutting off the 5 Cyphers and there remains 2 Perches, so is the whole content cast up, found 5 Acres, 2 Roods and 2 Perches, as by the Example in the Margin.

Exam.	1050
	525
	5250
	2100
	5250
Acres.	5 | 51250
	4
Roods.	2 | 05000
	40
Perches	2 | 00000

CHAP.

CHAP. V.

The Explanation and Use of several other Chains.

The Description and Use of Mr. Rathbourn's *Chain.*

THere remains yet to speak of one more Decimal-Chain, Composed by that excellent Artist Mr. *Aaron Rathbourn*, which is most Proper in taking Dimensions of Gardens, Orchards, and Ground-Plots of Houses and small Inclosures, in respect of the smallness of the Divisions of this Chain, for the whole Chain (usually 2 Pole in length) is divided into Primes and Seconds, that is, each Pole is Divided into 100 Links, *viz.* First it is divided into 10 equal parts, which he calls Primes, and each of those parts divided into 10 more equal Parts call'd Seconds; but there is no Scale absolutely proper to the division of this Chain, neither have I leisure now to do it, but shall give you one Example, how the Dimensions taken thereby are cast up.

EXAMPLE.

Suppose a piece of Land, in form of an Oblong, be 52 Pole, 3 Primes, and 2 Seconds one way; and 13 Poles, 7 Primes, and 4 Seconds, the other way: first observe to put pricks between the Decimal parts and Integers, *viz.* betwixt the Poles and Primes, as in the Margent; then multiply them as whole Numbers, and the Product amounts to 7188768; now forasmuch as there are four places of Decimals, *viz.* 2 in the Multiplicator, and 2 in the Multiplicand, you must Separate by a prick or dott, four figures towards the Right-hand, and the product will stand as you see in the Example, that is 718 Perches, and $\frac{8768}{10000}$ parts of a Perch.

```
    52.32
    13.74
  -------
    20928
   36624
  15696
  5232
  -------
 718.8768
```

Of the Vulgar Chain, and Statute-Measure.

There are some Surveyors that I am acquainted with, work by a Chain of $16\frac{1}{2}$ Links in a *Pole*, each Link being a Foot, and one Link of half a Foot in each *Pole*, to make it Statute-measure; for according to the Statute of 33 *Edward* the *First*, 16 Foot and a half is a Perch for Inclosure and Arable measure, but for Wood-land 18 is the usual *Perch*, and for Forrest-measure 24: This Chain of $16\frac{1}{2}$ Links in each *Pole* is only applicable to

Vulgar

Vulgar-Arithmetick, and the divisions too large to be Trusted in the Measuring of Leys or Arable, where Lands in open Fields are to be measured severally, which perhaps many times are of great Length, and very Narrow, that it cannot be sufficiently exact in the Operation, for the Reasons before given.

Of the Foot Chain.

There is also another Chain, which I sometimes make Use of, in measuring and Plotting the Ground-*Plots* of Houses, and Gardens, Orchards, Yards, and such like; as shall be Exemplified in its proper place, which Chain hath no respect for Land-measure, the whole length of the Chain consists of 60 Links, each Link being one Foot in Length; hence the length of the Chain is 60 Foot, or 20 Yards; with this Chain I Use a Scale of equal *Parts*, a Yard being the Integer, so that the Content is given and *Protracted*, in Yards, Feet, and Inches, and this shall be farther explained in the following Part.

CHAP. VI.

To Reduce Perches into Acres several ways.

THE Content or quantity of any Land, Ground, or Inclosure is first found (by the two foregoing Chapters) in *Perches*, which must be reduced into Acres, which is here performed several ways.

First therefore, as 160 *Perches* is contained in an Acre, and 40 *Perches* in one Rood, it therefore follows, that these are the proper Divisors, for if the Number of the *Perches* given be divided by 160, the Result in the Quotient is Acres, and if the Remainder exceed 40, divide it by 40, so is the Quotient, Roods, and the Remainder, *Perches*.

EXAMPLE.

Suppose 17996 *Perches* were given to be Reduced into Acres, Divide it by 160, the Quotient is 112 Acres and 76 remaining, which divide by 40, the Quotient is 1 Rood, and the remainder is 36 *Perches*, and this is the Old and usual Method, and is practised by all or most Authors.

17996
160 *Divisor.*
―――――
199
160 (112 *Acres.*
―――――
396
160
320
―――――
76 *Remains.*
40 *Divisor.*
―――――
Perches 36 (1 *Rood.*

II. EXAM-

II. EXAMPLE. *Performed another Way.*

But this Work may more readily be performed by Dividing th number of Perches by 4, first cutting off the Right-hand figure of the Perches, and that Quotient being again divided by 4, so will the Quotient appear in Acres, Roods, and Perches, as the Example in the Margent directs.

133
4) 1799 (6
449

A.	*R.*	*P.*
112	1	36

In the Third place, I shall here deliver a more Concise Way, how to convert Perches into Acres, by Multiplication.

III. EXAMPLE. *Performed by Multiplication.*

First Therefore, Multiply the number of Perches given, by (this Constitute Number) .625, and from that Product cut off 5 figures towards the Right-hand, so will those on the Left-hand be Acres; then Multiply those figures cut off on the Right-hand by 4, and from that Product cut off 5 figures to the Right-hand, so will the figure on the Left-hand be Roods; then again Multiply the 5 figures last cut off by 40, and from that Product cut of 5 figures as before, so will the figures on the Left-hand be Perches as before; which is exemplified in the Margent by the former Numbers.

	17996
	.625
	89980
	35992
	107976
Acres.	112.47500
	4
Roods.	1.90000
	40
Perches	36.00000

CHAP. VII.

The Description and Explanation of the Emperial Table *comprehending (and fully supplying) the* Plain Table, Theodolite, Circumferenter, Peractor, Chard *and* Needle, *never before Extant.*

THis Instrument is made either in Brass or Wood, but since the figure of it is too large to Insert in this Place, I shall briefly explain the making of it in Brass, by which both

the Instrument-maker, and Surveyor may easily perceive how it may be made in Wood.

Let this Plate of Brass contain in length 16 Inches, and in breadth 13 Inches, and if the Brass be well Planished and Polished, $\frac{1}{10}$ of an Inch in Thickness is sufficient, in the middle whereof either way from the Centre 3 Inches, is cut out a round piece of Brass, which Plate will be 6 Inches Diameter, and Consequently the hole thus cut out, the same: to this hole or vacancy of the Instrument is underneath fixed a Box of Brass, falling below the Superficies of the upper side of the Table $\frac{1}{2}$ an Inch, or something more, to contain the Chard and Needle therein; upon the back side of the Box, let the Socket be Screwed on, that the head of the Three Legged Staff is to move in. And here observe, that the Needle is to be covered with clear Glass, the upper side of the Glass lying somewhat lower than the thickness of the Plate of Brass, from the upper side of the Instrument, so that when the Plate of 6 Inches Diameter (before cut out) comes to be laid over the Glass, it may rest upon two small cross Bars lying close upon the Glass, to prevent the breaking of the said Glass: These cross Bars are for other use as presently follows, and the upper side of this small Plate is to lye on in this Posture, when the Instrument is used as a Plain Table, and to be taken away when the Instrument is to be used as a Theodolite, Circumferenter, Peractor, or Needle. This Plate of Brass that covers the Needle, is to its largest extent made into a Quadrant, for the taking of Altitudes as also the hour of the Day, and for the resolving several propositions of the Sphere. There is also belonging to this Instrument a Frame of Brass (without Joynts) to go upon the Table, to fasten a sheet of Paper thereon, which Frame is Screwed down with Screws, from under the Table, through little Nebs of Brass fastned to the Table, that stand Just the breadth of the Frame.

To this Instrument belongs a pair of Sights (which may be taken from the Index to supply this Place) to be Screwed upon the Table in the Diameter-line, agreeing with the North and South points of the Chard, which Sights thus placed are of excellent use with the Needle, and in respect of the Considerable distance they are placed one from another, will be more exact than any to this purpose before invented.

Thus far of the general explication of this Instrument, in the next place, *viz.* in the two following Chapters, we shall shew what Lines and Circles are thereon to be inserted, and what use they Generally serve for.

CHAP.

CHAP. VIII.

Of the Description and Division of the Chard, *as it stands placed in the Centre of the Circles of the Instrument.*

1 THe Chard over which the Needle is to play, has its Lim b Divided into 360 equal parts or Degrees, and if Concentric Circles be drawn, then each of them Degrees to be again divided into as many equal Parts as the distance will admit of, as each Degree into halves being 30 Minutes, and these again into halves being 15 minutes, and these into 3 parts being to every 5th. minute, if the Divisions will bear it.

II. Next, within this Division (at a convenient distance) is another Circle divided into 120 equal parts or Degrees, which by the help of Concentric Circles, each degree may be divided into as many other lesser parts as the distance will admit of.

This Circle is adjusted equal to the Circle of the Instrument, for the expediting the work of the Circumferenter, and Peractor, and is the most excellent for use, in respect of its large Divisions.

III. There is also another Circle betwixt this and the Centre, divided into four times 90 Degrees, that is, the Circle is first divided into four Quadrants, and each Quadrant into 90 Degrees, Numbering them from the Meridian-Line of the Chard by 10, 20, &c. to 90, and thence backward, by 80, 70, 60, &c. to 0, and so likewise the other side of the Circle is to be numbered the contrary way.

IV. Betwixt this Circle and the Centre is placed the Several Concentric Circles, in the Inmost whereof is pla ed the Months and Days of the Year, and on the Outermost is Chara-racted the Hours, as also from an inward Concentric Circ e, as the several lines drawn from each Circle directs, as al o some other Circles Shewing the Suns Place and Azimuth.

CHAP. IX.

Of the several Circles and Scales upon the Emperial Table, *their Division and Explanation.*

I. LEt there be a Circle drawn to the utmost extent of the Instrument, whose Diameter will contain 12 Inches and an half, for the Table being 13 Inches broad, it may very well

be extended within a Quarter of an Inch of either Side, which divide into 360 equal parts, or Degrees, and by help of Concentric Circles, this Limb may be divided into as many equal parts as the distance will admit of, which Circle performeth the work of the Theodolite, and here Note that this Circle thus divided, together with the Needle as 'tis placed on the Table, is a perfect Theodolite, and better for use than the ordinary one, First in respect 'tis larger, and secondly in respect of the other Circles placed by it, which doubly confirms it, as will sufficiently appear in the following part of this Book.

II. The next Circle (betwixt this and the Centre) is divided into four Quadrants, and each Quadrant into 90 Degrees, answerable to that in the Chard divided into four 90s, and tho' this division of the Circle is taken little or no Notice of, in the Practick part of Surveying, by any Authors I have yet met with, yet I shall have more respect for it, as may appear in the following Part.

III. Next, within this aforementioned Circle is projected another Circle, which is divided into 120 equal parts or Degrees, which by the help of the Concentric Circles each Degree may be divided into halves and quarters, and consequently into every 5th. Minute at least: and here Note that any of the 3 degrees in any of the former Circles, makes but one of these, and every 10 of these makes 30 of them, so that more exactness may be expected from the Circle thus divided, than from any of the former, which Division performes the worke of the Circumferenter and is a perfect Peractor, according to Mr. *Rathbourn's* Composition; as you may see in his Surveyor, *Lib.* 3. *Chap.* 5th. Page 129, which includes all the Circles upon this Instrument.

IV. At one end of this *Table*, betwixt the Limb and the Frame, may be placed the new Decimal Scale, as is treated of and described in the 3 Chapter of this Book, which will be useful when you have no occasion to take your Index with you, which may fall out at such times as you use the Needle only, with the Sights fastened to the Table, as I before Described, which Way is most proper to be followed in Surveying of Woods, Forests, and such like Places, where you cannot see any considerable distance before you, which Scale will be ready to use with the Protractor, or Line of Right Sines, when you come to transfer the lines taken in the Field therefrom upon Paper, and to shew the true Map as well as the content thereof, for when the Map is thus given, your Scale is here ready to find the true Content also of your Map, as will necessarily be required.

V. On the other end of the Table betwixt the Limb and the Frame, may be graduated the Lines of Artificial Sines and Tangents, and Numbers, which will be found of great use in the Solution of Triangles, which will be of considerable consequence, in the Practice of Surveying.

VI.

VI. 'Tis Requisite to have a Line of Chords, which the Limb of the Quadrant affordeth, being a Line of Chords of a very convenient Size, however betwixt the innermost Circle, and the Chard and Needle, is a convenient place to insert several lines of Chords to several *Radius*'s, and also lines of Right Sines, to be used instead of a Protractor.

VII. The Frame of the Table is graduated with lines of equal Parts call'd Inches, round about, and serving chiefly for shifting of Paper upon the Table.

VIII. Note that there goeth two small Cross Bars over the Glass and Needle, Centring just over the Centre of the Needle, with a little Hole in the Centre of the Bars, and exactly over the Centre of the Needle, to place one of the Compass-points in, to lay the edge of your Index by, when you are to direct the Sights to any Mark (or Object) set up in the Field; which Cross Bars will also keep the quadrantal (or round) plate before cut out, from falling upon the Glass, to preserve it from danger of breaking.

IX. I have only one more Principal Matter to insist on in this place, *viz.* That, which way soever your work by this Instrument (the PLAIN TABLE way excepted) you may make your Observations by every one of these ways at once, which are before mentioned: I do not mean only at every Angle taken in the Field, but the whole will be confirmed, as well as each particular Angle; all which may appear at one and the same time from this Instrument, by working according to the THEODOLITE, CIRCUMFERENTER, PERACTOR, and NEEDLE; and since I shall in the following Part make this Assertion experimentally good, I shall not need to say any thing more of it in this place.

CHAP. X.

Of the Protractor *and its several Divisions and Scales, fitted to the* Emperial Table.

THE PROTRACTOR is made of a Plate of fine thin Brass, containing Six Inches in length and three Inches and half in breadth, whose Limb or Semicircle must be Divided into 180 Degrees, numbered from the Left side, by 10, 20, 30, to 180: Then beginning at the same side again with 190, and so progressively to 360; which Division of the Protractor, serves

ſerves for the Protraction of thoſe Lines and Angles that are made by that Diviſion upon the TABLE, *viz.* The Circle of the THEODOLITE divided into 360 Degrees. But when you are to Protract the Angles given by that Circle that is Divided into a 120 Degrees, (which Circle performs the work of the CIRCUMFERENTER and PERACTOR) then your PROTRACTOR muſt be Divided accordingly, *viz.* The Semicircle thereof Divided into 60 equal Parts or Degrees, and beginning at the ſame end again, and numbered to 120, which is anſwerable to that Circle on the TABLE; which Diviſion may be put upon the other ſide of the PROTRACTOR, ſo that it will be compleated to all the ſeveral Circles comprehended upon the EMPERIAL TABLE. For the firſt Diviſion, *viz.* That of 360 Degrees will ſerve for that Circle of four 90s as well as one for that purpoſe; for as the firſt Quadrant of the Limb is Numbered to 90, ſo tis but counting on from 90 backwards, *viz.* 80, 70, 60, *&c.* to 0, as a little practice, in its proper place, will make plain. Then on both ſides are Scales of equal parts, Numbered by 10, 20, 30, *&c.* and at the bottom is a Line of equal parts alſo, and Numbered by 10, 20, 30, 40, *&c.* which Scales are to be graduated on both ſides of the PROTRACTOR.

The uſe of this Inſtrument in all its parts, will beſt appear by laying down therefrom the ſeveral Obſervations taken in the Field; as the ſeveral Examples in the following Part exemplifieth.

The making of this Inſtrument is ſo well known to every Mathematical Inſtrument-Maker, that I ſhall not need to inſert its Figure here.

CHAP. XI.

Of the ſeveral Inſtruments *for Reducing Plots to a greater or leſſer proportion, and what Method is ſafeſt to follow.*

THere hath been Variety of RULARS and other Methods, contrived for the Reducing of Plots to a greater or leſſer proportion, as ſhall be required; and that moſt of them to very good purpoſe: As that eſpecially of Mr. *Aaron Rathbourn*'s Invention; which is a Rular of what convenient length you pleaſe, and a Line drawn the length thereof, and divided into 100 equal parts, from the Centre-hole of the Rular, and alſo Numbered from the Center by 10, 20, 30, *&c.* to 100; through which Centre-hole is a Bodkin, Pin, or Needle, put through and faſtned (through the Plot you intend to Reduce) to the Table, ſo that the Rular may have its liberty to move about its Centre ſo con-

confin'd. But the way of Reducing a Map to any proportion assigned that I most affect as the surest way, is to Plot your Map over again (from the Map you have taken) by a lesser or greater Scale as the Matter is required, though indeed I cannot say, that the way of Reducing by Squares is much inferiour to any, for 'tis both plain and practicable; for if the Map to be reduced be incompassed with one great Square, *viz.* Taking in and leaving out some little matter of your Plot to be reduced, then divide that Square into several little Squares as occasion requires, which are laid down by some known Scale of equal parts, then observe to make the like number of Squares (lesser or greater according as the Matter requireth) by a Scale fitting the proportion assigned, then observe what part of the Square, any Angle or Remarkable Accident falls in, and accordingly prick it off by your proposed Scale in your new or intended Map, and by observing the Method, this whole Work may be perfected, as shall be Illustrated by Examples in its proper place.

CHAP. XII.

The Manner or Way of making a Field-Book, *proper to the several Instruments Issuing from the* Emperial Table.

FOR The effecting this Matter, provide a quantity of Paper, more or less, as the Work shall require; which bind up into a Long Octavo, or Semi-Folio, and Divide each side according to the following Directions: Let the side of each Leaf be divided into five Columns; the first is to contain the Names of each Angle Alphabetically, as the Angles A, B, C, D, *&c.* The second and third Columns, are for the Degrees and Minutes, Cut by the Index upon the THEODOLITE, or the PERACTOR, or the Angles observed by the NEEDLE upon the Chard, for the CIRCUMFERENTER and the Magnetical way; the fourth and fifth are for the length of the Lines in the Field-Book, in Poles and Links.

The Form of the Field-Book.

Angles.	Degrees.	Minutes.	Poles.	Links.
A	51	20	80	11
B	21	45	29	17
C	76	50	78	12
D	80	30	42	15

There

There may be two Columns more added to the Right-hand, for taking Notice of the off-Sets, both to the Right and Left-hand, and here Note, for working by the NEEDLE with that Circle of the Chard divided into four 90^{s}, that when the Degrees cut by the Needle in taking of an Angle exceed 90 Degrees, from the South-point of the Meridian-line on the Chard, then observe to insert its quantity and Coasting above 90 Degrees, *viz.* from the East or West-Points.

But I shall here insert the method of another FIELD-BOOK to more purpose, which includes all the Observations taken at once, *viz.* the THEODOLITE, PERACTOR, CIRCUMFERENTER, and NEEDLE, which take as followeth.

The Form of the New Field-Book.

The		Circle 360		Circle 120		Circle four 90^{s}			Measure.	
Angles.		D.	M.	D.	M.	Coast	D.	M.	Po.	Li.
1	A	16	45	5	35	N E	16	45	35	18
2	B	100	15	33	25	S E	79	45	35	8
3	C	111	20	37	7	S E	68	40	30	15
4	D	136	50	45	37	S E	43	10	38	19

The very Titles of this Field-Book explains it, especially if the former be rightly understood, so that nothing more need be said here for Explanation.

CHAP. XIII.

Shewing what part of Surveying *each way here delivered from the* Emperial Table *is most proper, and fittest to be used on all occasions.*

VArious are the Methods as well as Instruments that have been contriv'd and invented, for the perfection of this useful Art of Surveying, tho' not any one of them sufficiently to be confided in for all purposes, therefore I shall inform my Surveyor, what way or method is best to be observed and practised in all Cases that may happen, in the Practical part of Surveying, which this one Instrument I call the EMPERIAL TABLE will perform, with as much Celerity and exactness as all the Instruments that hath hitherto been invented, to proceed therefore methodically, I shall treat first of the

Plain Table,

Which is the only Inſtrument,that ever was invented,for taking the Map of ſmall Incloſures, and for ſhewing the true Symmetry thereof, and for taking the Map of a Town-ſhip, together with the Laying all the Lands, Meadow, and Incloſure, in the ſame Lordſhip, to the Town, as they lie reſpectively in the Field, by which Inſtrument may be deſcribed(very aptly)all Rivers, Water-courſes, Mountains, Mills, Ponds, Lakes, Quarries, Woods, Trees, and Buſhes, where-ever ſtanding, as alſo the Roads, Foot-paths, Gates, Stiles, with what-ever elſe is remarkable in the ſame Lordſhip. The Plain-Table is very excellent for taking of ſmall diſtances, as not exceeding a Mile, and whatever is required in this kind, it will not fail to perform with admirable plainneſs and perſpicuity: And ſo I come to the

Theodolite,

Which is beſt and moſt Applicable for the taking of a Map of a whole Country: For as the Plain Table is beſt and fitteſt for taking the Map of a Lordſhip, as the laying the particular Grounds one by another,and for the expreſſing what is remarkable therein: So is the Theodolite fitteſt for the deſcribing a Country, and the laying each Lordſhip, in its due place, true ſhape, and quantity, within the ſaid County-Map; on which may be deſcribed all the Rivers, Water-courſes, Towns, Ancient and Depopulated Places, and whatever places there are of Remark.

This Inſtrument is very uſeful in taking the Map of a Lordſhip in Groſs, *viz.* as tho' it were one intire Ground, which way is very helpful in the Incloſing of a Lordſhip, which is the firſt thing in that caſe that ought to be done, and this way may be ſafely practiced, in taking the Map and Content of any large Foreſt, Park, Chaſe, Wood, or ſuch like, and for taking of diſtances, whether Acceſſible or Inacceſſible; in ſhort, 'tis fitteſt for large and ſpacious performances, and ſo I come to the

Circumferenter and *Peractor.*

Both theſe Inſtruments being partly to the ſame purpoſe, and in reſpect of the largeneſs of the Degrees, (which in both Inſtruments are the ſame) it will be of tolerable good uſe in taking the Map, and finding the Content of Incloſure, or of a Lordſhip, and will indifferently ſerve for large matters, as what we before Intimated in the uſe of the *Theodolite*, and may very well

merit the Applause of all Artists, for the taking of Distances, whether Accessible or Inaccessible; and so we proceed to the

Chard and *Needle*.

Tho' I know some Surveyors that have so far confided in the Chard and Needle only, as to give in a Map and Content of a Lordship taken thereby, or other small Inclosures, yet I cannot advise any Surveyor to lay so great a Stress upon this Way, that must necessarily have so little congruity with truth; For first, in taking Angles in small Grounds, the Angles lying near together, or the many small Crooks in a River or Watercourse, when the NEEDLE shall scarce shew the difference betwixt one Angle and another, by reason of its Parvity and Restlessness. Secondly, it is subject to Variation, both in respect of Weather and of Iron, that may some times accidentally happen to be near it unknown to the Artist, or Stones of an Iron Nature, in the Ground where the Instrument is planted, which may also cause the NEEDLE to stand from its true Point or resting Place, therefore ought not to be rely'd upon, as so precisely exact, as the other ways before mentioned. But that which I recommend it for, and indeed cannot well be done any other way, is the taking of the Map and Content, of a Wood or Forest that is bounded with another Wood or Forest, that you are not concern'd in to measure (as very often happens in Practice) so that you cannot see any considerable Way before you; then by the direction of the NEEDLE you may be able to keep a straight line, as near the Wood side as you can guess, and so take the Angles either to you or from you, according as you are placed. Otherways by Observing at every Angle you plant your Instrument at, what Angle the NEEDLE makes with the Meridian-Line, which distance shall be the true quantity thereof, and by measuring these distances with your Chain, and inserted into your FIELD-BOOK, and so proceeding round the whole Wood or Forest: then you may, by the help of your PROTRACTOR and FIELD-BOOK lay down the true Map thereof, and therefrom find its just content or quantity, as shall be exemplified in its proper place.

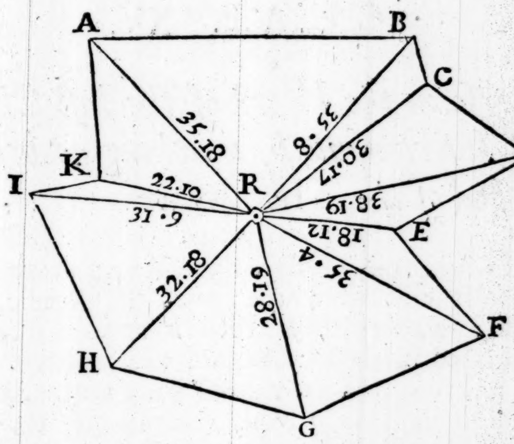
And here observe, the Sights taken from the Index, and fixed (as in the description *page* 177 or 178) upon the TABLE, that is here to be used.

CHAP.

CHAP. XIV.

How to take the Exact Plot of a Field at one Station, from whence may be seen all the Angles of the Field, by the Plain Table.

BEfore you place your TABLE, cause Marks to be set up in every Corner of the Field, as in ABCDEFGHIK, which let be the Field given to be measured; then plant your Table at some convenient Place in the Ground, from whence may be seen all the Angles or Corners therein, as at R, there plant your TABLE covered with a sheet of fair Paper, which is put upon the Table as is directed *page* 87: Your Table thus planted, lay your Index upon it, having one Foot of your Compass-points pricked down on the Paper near the Centre of the Table; then bring the edge of your Index to the Compass-point, as it Remains fixed in the point R, having your Compasses in your Right-hand thus placed and your Index directed by your Left-hand, turn the Index about till through the Sights thereof you espie the White or Mark set up at the Angle A, then by the edge of your



Index draw the line R A, which distance Measure on the Ground with your Chain, which is found 35 Poles, 18 Links, which take from your Scale with your Compasses, and place it from R to A, where make a prick with your Compass-point. So in Like manner from the point R direct your Sights to B, and draw the line R B, which distance Measured with your Chain, is found 35 Poles, 8 Links, which take in your Compasses from your Scale and set it from R to B, then with your Black-lead Pencil draw the line A B, thus observing the same Method till the whole Map or Plot of the Field is taken.

 Or

Or if you direct your Sights to every Angle in the Field, and draw lines at length from R, by the edge of your Index, then measure each length upon the Ground with your Chain, which several distances so found take in your Compasses from your Scale, and place them down upon their respective lines in your Map, Making a prick at the end of each extent, then with your Black-lead Pencil draw small Lines from one prick to another, as from A to B, and from B to C, from C to D, and so on, till the whole Plot be Included.

Concerning the Rules Authors have delivered about taking the Plot of a Field at one Station, from any one Angle thereof, from whence all the Angles thereof may be seen, I shall not trouble the Reader, here with an Example, in respect, 'tis the same with the former; for if the TABLE be planted at any Angle in the Field, from whence all the Corners or Angles may be seen, 'tis but directing your Sights (from the Angle assigned) to all the Angles, drawing lines by the edge of your Index; then measuring their respective distances upon the Ground, with your Chain, which Dimensions take in your Compasses from your Scale, and place them upon each correspondent Line, making pricks at the full extent thereof, from which with your Black-lead Pencil draw lines, which shall include the Plot required.

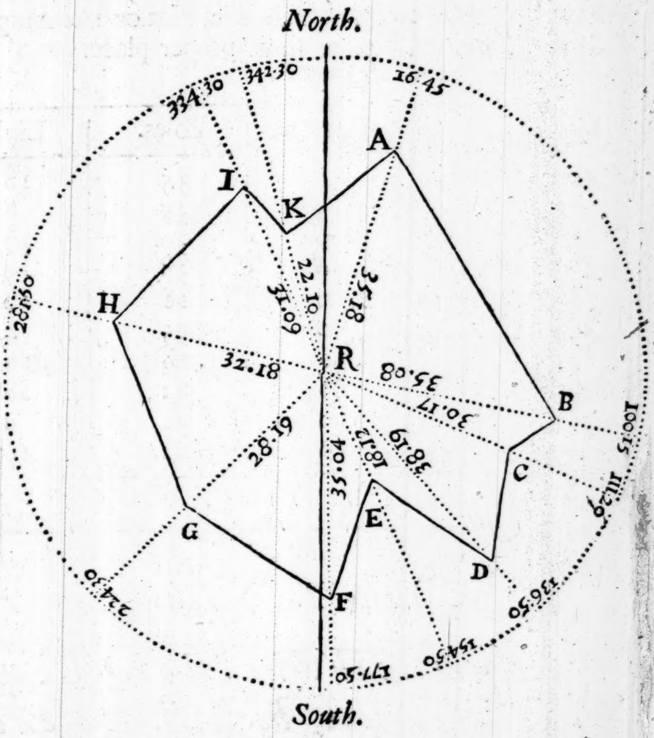
CHAP. XV.

How to perform the Work of the last Chapter, by this Instrument, by working according to the method of the Theodolite.

THE Paper being taken off from the TABLE together with the Quadrantal-plate which covers the Needle, at that time we use it as a plain Table, then it appears according to what we described in the IX Chapter, *viz.* a perfect THEODOLITE CIRCUMFERENTER PERACTOR, &c.

But to perform the former work according to the THEODOLITE, first plant your Instrument at R, turning the Table upon the head of the Staff till the NEEDLE shall hang directly over the Meridian Line in the CHARD, there Screw the Table fast, which done having your Index in your Left-hand upon the Table, and one of your Compass-points by your Right-hand placed in the Centre of the cross Bars, over the Centre of the CHARD and NEEDLE, to which Compass-point so fixed bring the edge of your Index, and direct the Sights to your first mark at A, observing (in the Innermost Circle divided into 360 Degrees) what Degrees the Index cutteth, which let be 16 Degrees, 45 Minutes, which

which put down in the Second and Third Column of you Field-Book against A, in the first Column, being the Angle Nominated, then with your Chain measure the distance upon the Ground, *viz.* from R, the place of your Instrument (or place of standing) to A; which is found 35 Poles, 18 Links, which place in the fourth and fifth Column of your Field-Book, against A; Then after the same manner direct your Sights to B, your second Mark, Noting the Degrees cut by the Index, which let be 100 Degrees, 15 Minutes, and the distance R B, is found 35 Poles, 8 Links, which note down in your Field-Book in the fourth and fifth Column (against B the Alphabetical name of the Angle in the first Column) and the 100 Deg. 15 Min. in the second and third Column. Then direct your Sights to C, finding the Degrees cut by the Index to be 111 Deg. 20 Min. and the Distance R C, to be 30 Poles, 17 Links, which 111 Deg. 20 Min. put down in the second and third Column of your Field-Book, and the length 30 Poles, 17 Links, in the Fourth and fifth Column thereof: Then again Direct your Sights to D, and note



the Degrees cut by the Index, which will be found 136 Degrees, 50 Minutes, then measure the distance R D 38 Poles, 19 Links; then put down D in the first Column of you Field-Book, and 136 Deg. 50 Min. in the Second and Third Columns, and 38 Poles, 19 Links in the fourth and fifth Columns thereof. Then Direct your Sights to E, and observe the Degrees the Index cuts, which

which let be 154 Deg. 50 Min. and the length R E, 18 Poles, 12 Links; which 154 Deg. 50 Min. and 18 Poles, 12 Links transfer into your Field-Book, in their proper Columns as before directed: Then direct your Sights to F, where finding the Index to cut 177 Deg. 50 Min. and the distance R F, 35 Poles, 4 Links, all which put down in your Field-Book according to the aforegoing Directions: Then direct your Sights to G, and Note the Degrees cut by the Index to be 224 Deg. 30 Min. and the distance R G, 28 Poles, 19 Links; all which put down into your Field-Book as before: Then direct your Sights to H, still Noting the Degrees cut by the Index, which let be 281 Deg. 50 Min. and the distance R H, 32 Poles, 18 Links, which Note down in your Field-Book: Then direct your Sights to I, Noting the Degrees cut by the Index, which we find 334 Deg. 30 Min. and the length R I, 31 Poles, 9 Links, which accordingly put down in your Field-Book: Then direct your Sights to K, your last Mark, observing the Index to cut 342 Deg. 30 Min. and the distance R K, 22 Poles, 10 Links, these Note down in your Field-Book also: So will you have the whole *Epitome* of your work in your Field-Book, which stands as in the following Table, from which the Plot or the Map is to be protracted, as we shall shew in its proper place.

Angles.		Degrees.	Minutes.	Poles.	Links.
1	A	16	45	35	18
2	B	100	15	35	8
3	C	111	20	30	17
4	D	136	50	38	19
5	E	154	50	18	12
6	F	177	50	35	4
7	G	224	30	28	19
8	H	281	50	32	18
9	I	334	30	31	9
10	K	342	30	22	10

CHAP. XVI.

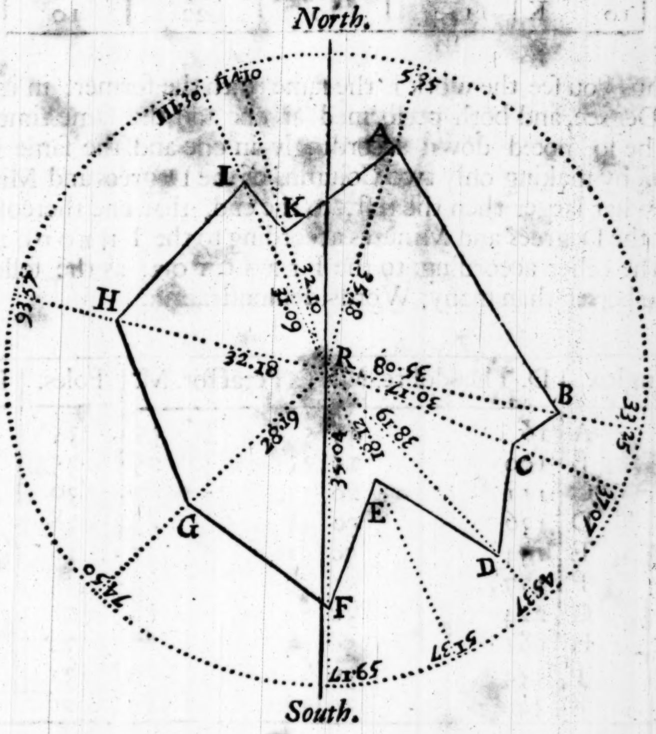
How to perform the Work of the last Chapter, from this Instrument, by working according to the Peractor.

THe difference between this way and the former consists only in the division of the Circle, for 'tis but making use of the Circle divided into 120 degrees, and the Angles cut accordingly by the Index, will shew the quantity of each Angle from

from that Circle also, which, with the length taken as in the last Chapter, and transfer'd into your Field-Book, in all respects as the former Chapter directs, will be the thing effected.

EXAMPLE.

Plant your Instrument at R, with the NEEDLE hanging directly over the Meridian-line, directing your Sights (as in the former Chapter) to A, Noting the Degrees cut by the Index, which let be 5 degrees, 35 minutes, which with the length R A, 35 Poles, 18 Links, Note down in your Field-Book, as in the last Chapter, then direct your Sights to B, Noting the degrees the



Index cuts, which let be be 33 degrees, 25 minutes, which with the length R B, 35 Poles, 8 Links, put down in your Field-Book. According to which method proceed in taking the rest of the Angles, and express them, with the length of the lines, taken in the Field with your Chain, in your Field-Book, which will be the exact *Epitome* of your whole work, and will stand thus.

Angles.

Angles.		Degrees.	Minutes.	Poles.	Links.
1	A	5	35	35	18
2	B	33	25	35	8
3	C	37	7	30	17
4	D	45	37	38	19
5	E	51	37	18	12
6	F	59	17	35	4
7	G	74	50	28	19
8	H	93	57	32	18
9	I	111	30	31	9
10	K	114	10	22	10

Thus you ſee the work is the ſame with the former, in its kind and Degree, and both performed at one and the ſame time, and may be ſo noted down accordingly in one and the ſame Field-Book, by making only two Columns of the Degrees and Minutes, ſomewhat larger then the reſt, to the end, that one thereof may ſhew the Degrees and Minutes according to the THEODOLITE, and the other according to the PERACTOR, as the following Table better than many Words demonſtrateth.

Angles.		D. Theodolite.	M.	D. Peractor.	M.	Poles.	Links.
1	A	16	45	5	35	35	18
2	B	100	15	33	25	35	8
3	C	111	20	37	7	30	17
4	D	136	50	45	37	38	19
5	E	154	50	51	37	18	12
6	F	177	50	59	17	35	4
7	G	224	30	74	50	28	19
8	H	281	50	93	57	32	18
9	I	334	30	111	30	31	9
10	K	342	30	114	10	22	10

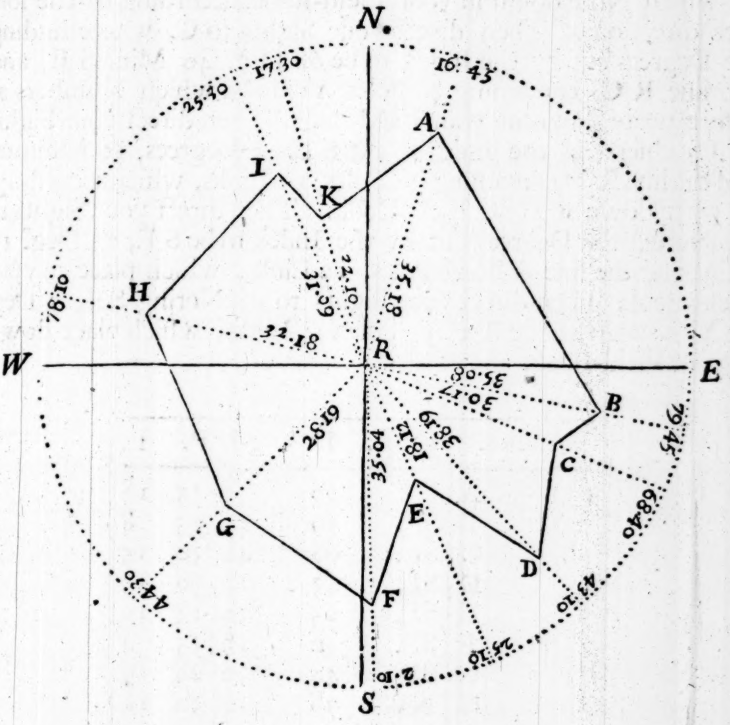
By this Table, and what I have juſt now ſaid, 'twill be eaſy to perceive the great advantage of this Inſtrument, which not only performs the work of theſe two Inſtruments at one and the ſame time, but confirms the work of both at the ſame Inſtant. And becauſe the work is performed both theſe ways at one and the ſame time, and at the ſame labour alſo, I ſhall therefore in the following Chapters demonſtrate the work of both the THEODOLITE and PERACTOR together, by obſerving the Angles in both Circles, and by transferring them into the Field-Book, as this laſt Table directs, in reſpect, 'tis much more helpful and intelligible,

CHAP.

CHAP. XVII.

To perform the work of the last Chapter, by the Circle upon the Table, that is divided into four 90s; And also how the work of these three last Chapters (by this Instrument) may be most compendiously performed at the same time.

IN the performing of the aforegoing work by the Circle on the TABLE divided into four 90s, you must have your Field-Book ordered accordingly, which is to be divided for this purpose into three Columns; the first is to contain the Letters and Figures progressively, being the Name and Number of each Angle; the



second must be of considerable breadth, so that it may contain the Number of Degrees and Minutes cut by the Index, and also the Quarter of the Compass in which the degrees are cut by the Index from the North or South points, towards the East or West; the

 third

third Column is to contain the Poles and Links, being the length of each line taken in the Field. But before you proceed to plant your Instrument, set up marks in every corner of the Field, as at A B C D E F G H I K, which done plant your Instrument (as before) at R, with the NEEDLE hanging directly over the Meridian line in the CHARD, with the North end toward you, in which posture Screw it fast, then as in your former Chapter direct your Sights to A, Noting the degrees cut by your Index in the aforenamed Circle, which let be 16 degrees, 46 minutes, in the North-East quadrant, and the length of the line R A, 35 Poles, 18 Links, which put down in your Field-Book, as the following Table directs, *viz.* place in the first Column 1 and A, which denotes the first Angle, known by the Name A: Secondly set down in the second Column 16 Degrees, 45 Minutes, which is the quantity of the Angle, from the North towards the East: Thirdly place down in the third Column the length of R A, 35 Poles, 18 Links. Then direct your Sights to B, Noting the Degrees upon this Circle that the Index cuts, which let be 79 Degrees, 45 Minutes, S E, that is, so many Degrees from the South towards the East, and the length R B, 35 Poles, 8 Links, all which Note down in your Field-Book according to the former directions. Then direct your Sights to C, where finding the Degrees cut by the Index to be 68 Deg. 40 Min. S E, and the line R C, containing 30 Poles, 15 links, which Numbers as before write down in your Field-Book. Then direct your Sights to D, observing the Index to cut S E. 43 Degrees, 10 Minutes, and the line R D, containing 38 Poles, 19 Links, which accordingly place down in your Field-Book. Then direct your Sights to E, Noting the Degrees cut by the Index to be S E, 25 Deg. 10 Min. and the line R E, 18 Poles, 12 Links, which place in your Field-Book. Then direct your Sights to F, Noting S E, 2 Deg. 10 Min. and the line R F, 35 Poles, 4 Links, which place down in your Field-Book.

Angles.		Coast.	D.	M.	P.	L.
1	A	NE.	16	45	35	18
2	B	SE.	79	45	35	8
3	C	SE.	68	40	30	15
4	D	SE.	43	10	38	19
5	E	SE.	25	10	18	12
6	F	SE.	2	10	35	4
7	G	SW.	44	30	28	19
8	H	NW.	78	10	32	18
9	I	NW.	25	30	31	9
10	K	NW.	17	30	22	10

By thus much 'tis easie to perceive how the rest of the Angles are to be taken, with the length of the several Lines leading to each

each Angle, and alſo how to place them in your Field-Book: which done, the whole Work ſtands in your Field-Book as the aforegoing Table directs, from which your Plot is to be Protracted.

Angles.		Circle. 360 D.	M.	Circle. 120 D.	M.	Circle four 90s Coaſt.	D.	M.	Meaſure. P.	L.
1	A	16	45	5	35	NE.	16	45	35	18
2	B	100	15	33	25	SE.	79	45	35	8
3	C	111	20	37	7	SE.	68	40	30	15
4	D	136	50	45	37	SE.	43	10	38	19
5	E	154	50	51	37	SE.	25	10	18	12
6	F	177	50	59	17	SE.	2	10	35	4
7	G	224	30	74	50	SW.	44	30	28	19
8	H	281	50	93	57	NW.	78	10	32	18
9	I	334	30	111	30	NW.	25	30	31	9
10	K	342	30	114	10	NW.	17	30	22	10

And here Note, that the work of theſe thr ee laſt Chapters may all be performed at one and the ſame time; for the directions are alike in all of them, only obſerving to enter the quantity of each Angle into your Field-Book from each Circle into its proper Column, as the Table Demonſtrates. And tho' in theſe three laſt Chapters, I have largely treated of each ſeveral way, becauſe it might beſt ſuit with the humours and qualifications of all Artiſts, yet I do wholly recommend the ſober Artiſt, to make his Obſervation of all the three Circles at once, for the Index will cut all the Angles in the three ſeveral Circles at one time, and your Field-Book, as in this laſt Table, may be made with as little trouble to contain the Theodolite, Peractor, and Circle of four 90s, the work of which three Inſtruments you ſee is performed at one operation, with the ſame eaſe and labour that any one of them takes or requires, which is a ſure way alſo to prevent miſtakes, by comparing the correſpondent Numbers of your ſeveral Angles in your Field-Book, by conſidering the proportion one Circle bears to another.

 CHAP.

CHAP. XVIII.

How to take the Plot of the aforementioned Ground, by using the Instrument as a Circumferenter, *or* Chard *and* Needle.

OUR First business is to fit this EMPERIAL-TABLE to a CIRCUMFERENTER, &c. which is done by taking the Sights from the Index and Screwing them upon the Meridian line on the Table, as was directed in the 7th Chapter, so that the sights thus placed, are fixed to the Table, and move as the Table moves, and the Angles (by the Degrees in the Chard) are to be observed from the South end of the Needle, by any one or all the Circles in the Chard, as we have instanced in the work of the three last Chapters, for as the work of the three last Chapters was performed by the Index cutting the several Circles upon the Table, so the work may be effected by the three Circles so severally divided in the Chard, by the Needle (according to the moving of the Table) making the same Angles on the several Circles of the Chard; and because I would not be prolix I shall observe the Angles to each Circle the Needle makes, tho' I cannot but mostly recommend the Circle of the Circumferenter, divided into 120 Degrees: However since I shall exemplifie the work in all the three Circles at once, leaving the Surveyor to take his Choice which one, or all the Circles at one time he will make use of, and by referring to the Figures in the three former Chapters, which are applicable to the Divisions of the three Circles in the Chard; we Illustrate as followeth.

EXAMPLE.

First, set or place marks in all the Angles or Corners of the Field, as in A B C D E F G H I K, then plant your Table Horozontally at R, with the Flower-de-luce towards you, turning it gently upon the Staff till through the Sights you espie the Mark at A, there Screw your Table fast, and observe what Degrees in the Chard the Needle hangeth over in each Circle, which in the Division of that Circle of 360 Degrees it cuts 16 Deg. 45 Min. and in the Circumferenter-Circle divided into 120 Deg. the Needle cuts 5 Deg. 35 Min. and in the Circle of four 90s, the Needle is found to rest upon NE. 16 Degrees, 45 Minutes, and the Length R A, measured on the Ground by the Chain, is found 35 Poles, 18 Links, all which Numbers note down in your Field-Book according to the last directions (for this purpose) of the last Chapter, in the Example of the Field-Book; which done,

done, unscrew your Table, and turn it about as before, till through the Sights you espie the Mark at B, there screw it fast, Noting the Degrees of the several Circles the Needle hangeth over, which in that of 360, is found 100 Deg. 15 Min. in that of 120, is found 33 Degrees, 25 Minutes; in the four 90s, SE 79 Degrees, 45 Min. and the length R B, containing 35 Poles, 8 Links, all which Note down in your Field-Book as before, then according to the former directions, direct (by moving the Table) the Sights to C, where the Needle is found to rest upon 111 Deg. 20 Min. in the Circle divided into 360 Deg. and cutteth also 37 Degrees, 7 Min. in that Circle divided into 120, and also the Needle rests upon SE 68 Deg. 40 Min. in the Circle of four 90s, and the length R C, is found to contain 30 Poles, 15 Links, all which Numbers accordingly place down in your Field-Book. And thus much is enough to ground a mean Capacity in the performance of the rest, for by observing the same Rule or Method, you cannot fail, and the Work in your Field-Book stands as the last Table in the last Chapter directs, from which the Plot is to be Protracted, as by the next Chapter.

Note, That whensoever the Plot of a Ground can be taken at one Station, be it in any Angle thereof, or in what other part of the Ground soever, the former directions hold good for the Performance thereof; for the Angles and Lines being taken according to the preceding directions (though different in respect of the Station's Situation) and accordingly entered into your Field-Book, the Plot may be Protracted thereby, and be the same as if drawn from observations made in any other place of the said Ground.

CHAP. XIX.

To lay down or Protract *upon Paper, the Work of the former Chapters.*

I. FIRST, draw a Line (your Field-Book lying before you) that shall represent the Meridian Line, or a line that shall point North and South, as in the figure of the 15th Chapter, which is Charactered at either end with NORTH and SOUTH; then according to the Circle your Angles were observed by, whether upon the Table by the Index, or in the Chard by the Needle, make use of that side of your PROTRACTOR that is graduated accordingly; then make choice of a convenient Place upon your fair Paper, that may represent your Station, or place of Standing as at (by referring to the Figure in the 15th Chapter) R, upon which point, place the Centre of your Protractor, laying the Meridian line of your Protractor directly upon the Meridian line of

of your Paper, as it is before represented with the Arch towards your Protractor, resting in this posture, look in your Field-Book for the quantity of your First Angle at A, which (according to this division of 360) is found 16 Degrees, 45 Minutes; therefore against 16 Degrees, 45 Minutes, in the Limb of your Protractor, make a mark or prick upon the Paper.

II. Then finding your Second Angle at B, to contain 100 Degrees, 15 Minutes, make a mark upon the Paper against 100 Degrees, 15 Minutes, of your Protractor.

III. Also finding your third Angle at C to contain 111 Degrees, 20 Minutes, against which in the limb of your Protractor, make a mark also.

IV. Your fourth Angle at D, is found by your Field-Book to contain 136 Degrees, 50 Minutes, against which in the limb of your Protractor, make a mark upon your Paper.

V. The Degrees observed at your fifth Angle at E, is found 154 Degrees, 50 Minutes, against which Number in your Protractor make a prick upon your Paper.

VI. Accordingly observe what Degrees are at the sixth Angle at F, which is found 177 Degrees 50 Minutes, which prick off from the limb of your Protractor upon your Paper.

VII. Then observing what Degrees are made at the Angle G, which is found to contain 224 Degrees, 30 Minutes, wherein observe that as 224 Degrees, 30 Minutes, is greater then 180 Degrees, The Arch of your Protractor must therefore be turned downwards, still keeping the Meridian line of your Protractor upon the Meridian line of your Paper, in which posture it is to lye till your work be finished.

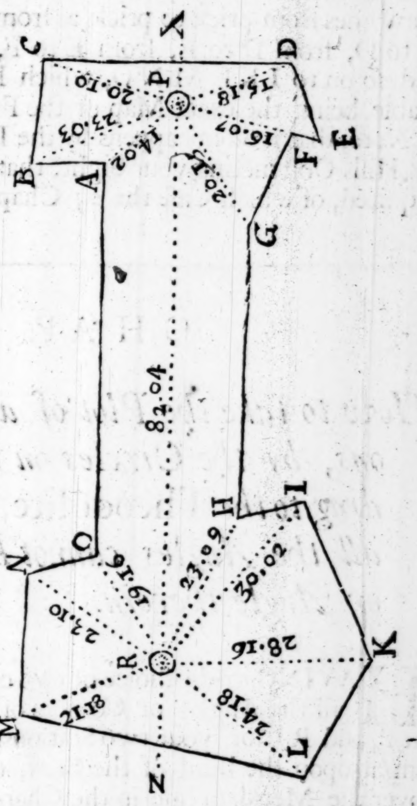
Then observe the 224 Degrees, 30 Minutes upon your Protractor, against which make a mark upon the Paper as before. Thus according to the preceding directions prick off the Angles H, I, and K, from the Degrees in the limb of your Protractor; which being done, take your Protractor from the Paper, then lay a Rular from the point R, to each prick-mark made from your Protractor and draw obscure Lines, as RA, RB, RC, &c. then take the particular length proper to each Angle (as your Field-Book directs) from your Scale, and place them upon their respective Lines, as from R, to A, 35 Poles, 18 Links, which take from the Scale treated of in the third Chapter, and place it from R, to A; likewise from R, to B, was found 35 Poles, 8 Links, which accordingly take from your Scale, and set from R, to B; thus by observing this method, being directed accordingly by your Field-Book, the length of all the other lines may be set off, as the Field-Book, and the Figure Demonstrates; which done, draw lines from prick to prick, as from A, to B, and from B, to C, from C, to D, and from D, to E, from E to F, and so round to A, which includes the Plot required.

CHAP.

CHAP. XX.

To take the Plot of a Field at two Stations by the Plain-Table, *when all the Angles cannot be seen from one place or Angle therein.*

YOUR Quadrantal Plate laid over the Chard and Needle, and the Table covered with clean Paper, and the Sights first taken therefrom, and Screw'd upon the Index; having thus fitted your Instruments and in the Field you are to Measure and to take the Plot thereof, which cannot be done at less than two Stations, in respect all the Angles cannot be seen from any one place of the Ground. We will therefore suppose this following figure to be a Field or Ground to be Measured, Noted with the Letters A B C D E F G H I K L M N O, which is apparent enough (supposing no Hills to be in it) that it cannot be performed at any one Station, from any one Place therein, by reason all the Corners cannot be seen from any one place therein.



First then make choice of two convenient places, wherein all the Angles may be seen, which Stationary distance let be as long as convenient you can, as P and R, which are to be your Stations or places of standing, wherefrom all the Angles may be seen and taken: This considered, and Whites set up in all the Angles, place your TABLE at P, where let it be fast Screw'd, with respect to the Situation of the Ground, for the better bringing the Work all upon the Table, then direct your Sights (as directed in the 14 Chapter) to all the Corners or Angles, within Sight; as to A B C D E F G, drawing lines by the edge of your Index towards each Angle, as the prickt lines here denote, which done

done measure every one of the lines on the Ground with your Chain, and Note them down from your Scale upon the correspondent lines; your TABLE remaining fixed, direct your Sights to the other Station at R, and draw a line at length at the end of your Index as X Z, then take up your Table, and measure (as you go along) the stationary distance PR, which is found 82 Poles, 4 Links, which place from P, to R, by help of your Scale and Compasses.

Secondly plant your TABLE at R, laying the edge of your Index upou the Stationary line R P, and turn the Table gently about (upon the head of your Staff) till through the Sights you espie your first Station at P, there screw it fast; then direct the Index from your Station at R, to all the other Angles, as to H I K L M N O, and draw obscure lines by the edge of your Index as before: which done, measure with your Chain from your Station to each Angle, which several distances take in your Compasses, from your Scale, and set them from your Station at R, to H I K L M N O; lastly draw lines from prick to prick, as from A to B, from B to C, from C to D, from D to E, from E to F, thence to G, and so to H, and so on to I K L M N O, which Includes the Plot upon your Table, being the exact Map of the Field, as was required.

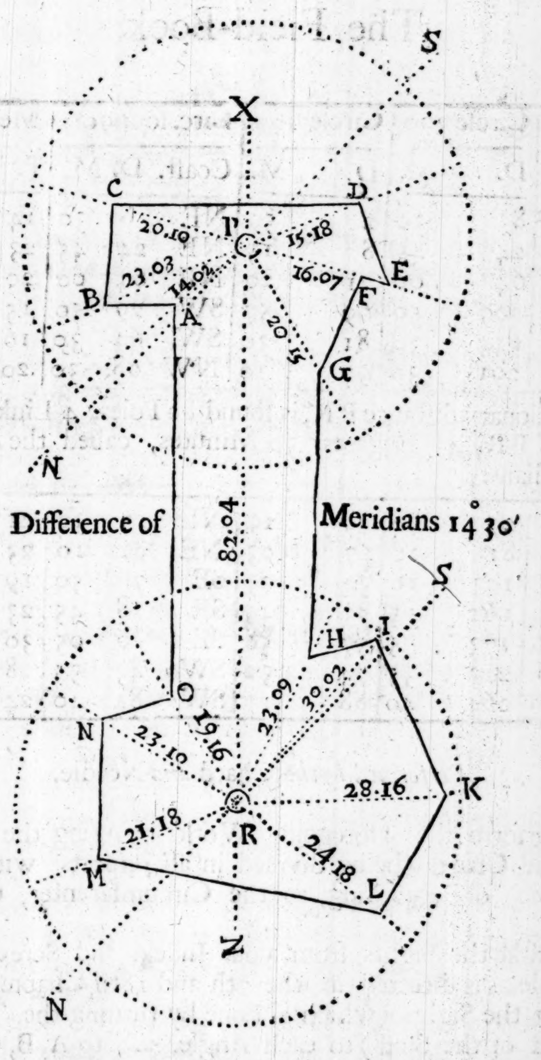
Note, that it often happens by the Irregularity of the Fences, or by Hills Obstructing your Sight, that more stations than two are required, of which Case the 23 Chapter will fully inform you.

CHAP. XXI.

How to take the Plot of a Field at two Stations, by the Circles on the Table, *or according to the* Theodolite, Peractor, *&c. when all the Angles cannot be seen from one place or Angle therein.*

HAVING made choice of two convenient places, (from which all the Angles or Corners of the Ground may be seen, as at P, and R) for your two Stations, plant your Table at P, turning it upon the head of the Staff, till the Needle hang directly over the Meridian line in the Chard, there screw it fast; then as is directed in the 15 Chapter, direct your Sights to all the Angles in view, *viz.* to A, B, C, D, E, F, G, and observe the Degrees cut by the edge of your Index, upon one or all the three Circles upon the Table, and Note the Angles (from each Circle) down in your Field-Book, with the length of each line, as here you see; which done, direct your Sights to R, your Second Station, where

where finding the edge of the Index (in the Circle of 360) to cut 41 Degrees, 30 Minutes, which note down in your Field-Book, in a space for that purpose, which 41 Degrees 30 Minutes, is called the difference of Meridians: Having thus finished this part of the Field, remove your Instrument to your other Station at R, (measuring the Stationary distance as you come on)



and laying the Index upon 41 Degrees, 30 Minutes, the difference Meridians, turning the Instrument about till through the Sights you espie the mark set up at your first Station at P, so will the Needle (as before) hang over the Meridian line in the Chard, in which posture Screw it fast, then direct your Sights to the remaining Angles *viz.* to M, N, O, H, I, K, L, noting the Degrees

 cut

cut by the edge of the Index, upon one or all the Circles on the Table, and accordingly note them down in your Field-Book, with the true measure of the Stationary Distance, which is here found 82 Poles, 4 Links, and likewise the measure of all the other Angles from the Station they were observed from, all which collect in your Field-Book as the following Table directs, so will your work in the Field be finished.

The Field-Book.

The		Circle 360		Circle 120		Circ. four 90s			Meas.		Sta-
Angles.		D.	M.	D.	M.	Coast.	D.	M.	P.	L.	tions.
A	1	8	30	2	50	NE	8	30	14	02	First Station at P.
B	2	24	45	8	15	NE	24	45	23	03	
C	3	64	00	21	20	NE	64	00	20	10	
D	4	209	50	69	57	SW	29	50	15	18	
EF	5	244	30	81	30	SW	64	30	16	07	
G	6	291	30	97	10	NW	68	30	20	15	
The Stationary distance P R, is found 82 Poles, 4 Links, and the Angle N P R, 41 Degrees, 30 Minutes, called the difference of Meridians.											
M	1	27	30	9	10	NE	27	30	21	18	The Second Station at R.
N	2	81	10	27	03	NE	81	10	23	10	
O	3	103	10	34	23	SE	76	50	19	16	
H	4	161	15	53	45	SE	18	45	23	09	
I	5	173	55	57	58	SE	6	05	30	02	
K	6	223	35	74	32	SW	43	35	28	16	
L	7	264	40	88	13	SW	84	40	24	18	

Performed by the Chard *and* Needle.

To perform the aforegoing Work, by using the three Circles in the Chard (being divided in all respects with those on the Table) or according to the Circumferenter, Chard and Needle.

First take the Sights from your Index, and Screw them on the Table as is directed in the 7th and 18th Chapters, then by directing the Sights (which is done by turning the Table upon the head of the Staff) to each Angle, *viz.* to A, B, C, &c. you will find the Needle to cut the several Circles in the Chard, on the same Degrees and Minutes as the Index did the Circles on the Table, which needs no further explanation to perform the whole Work; for the directions are the same in all respects, the Needle performing here what the Index did there, and the Field-Book no ways different, so that 'tis needless to make any tedious (or farther) repetitions.

CHAP. XXII.

How to protract the work of the last Chapter.

TO avoid trouble, we ſhall refer to the aforegoing Figure.

First then, draw the Meridian line S P N, let P repreſent your firſt Station, upon which point place the Centre of your Protractor, laying the Meridian line of your Protractor upon the Meridian line of your Paper, at which time having your Field-Book before you, prick off the Angles (according to the diviſion of 360, in reſpect the difference of Meridians is noted from that Circle, which might at the ſame time alſo have been noted from both the other Circles, as every mean Capacity may underſtand) as your Field-Book directs; and draw lines from P, through theſe Marks, upon which lines ſet off the ſeveral lengths (taken in the Field) from P, as you find them Collected in your Field-Book.

The Obſervations of your firſt Station being thus finiſhed, before you remove your Protractor make a mark againſt 41 Degrees, 30 Minutes, which is for the difference of Meridians, and draw the line P R, upon which line from P, ſet off (your Stationary Diſtance) 82 Poles, 4 Links, to R; then upon the Stationary point R, place the Centre of your Protractor, as before, moving it up and down until the line P R lyes Juſt under 41 Degrees, 30 Minutes, to which place hold it faſt, and therefrom prick off all the Angles (taken at that Station) by the limb of your Protractor, as your Field-Book informs you; through which pricks draw lines from R, and ſet off therein the reſpective diſtances as they are noted down in your Field-Book: Laſtly, through which Points thus prickt off, *viz.* A B C D E F G H I K L M N O, draw lines, which ſhall include the true Plot of the ſaid Field upon your Paper.

☞ Here Note alſo that if all the Angles could not have been obſerved but that of neceſſity more Stations would have been required to have perfected the Work, it had been but obſerving the next Stationary diſtance, or difference of Meridians, *viz.* by directing your Sights from Station to Station, in the ſame order as in the laſt Chapter is directed, taking all the Angles (with the length of the lines) in View at each Station, and ſo proceeding from Station to Station till the whole be finiſhed, as preſently we ſhall further explain.

CHAP. XXIII.

To take the Plot of any Irregular Field at divers Stations, when all the Angles cannot be seen from one, two, or more Stations, by the Plain-Table, *by going round about the same.*

LET this Irregular Plot Noted with A B C D E F G H I K &c. represent some Irregular Field or Ground whose Map or Plot is required.

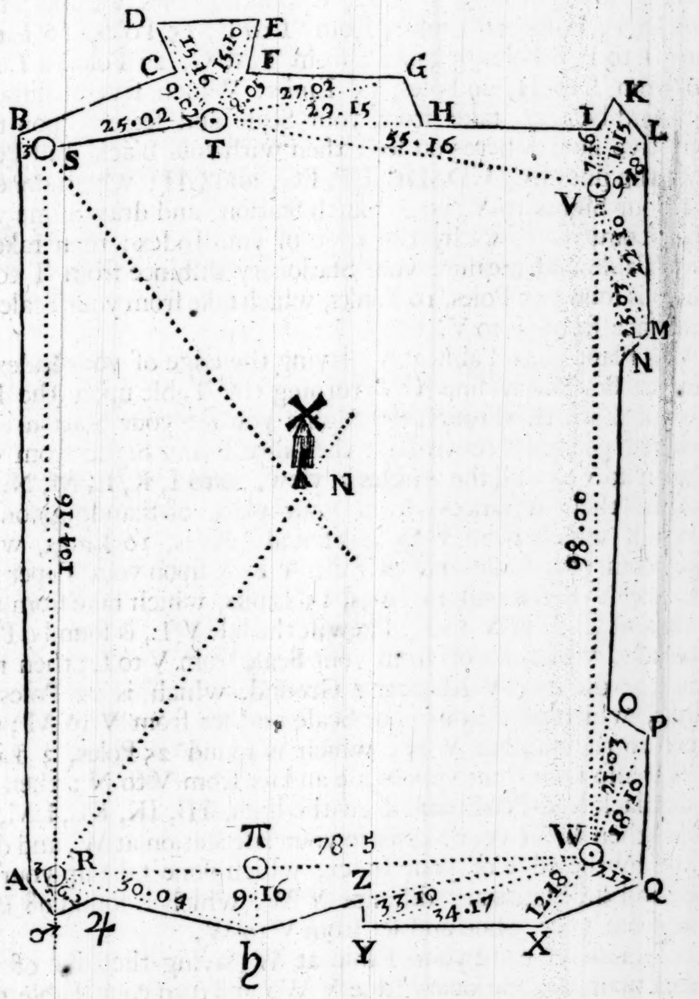
I. First therefore, make Choice of the most convenient places for your Stations, which are at R, S, T, V, W, which 5 Stations will perform the Work of the whole Ground, *viz.* all the Angles may be seen from them.

II. Secondly, set up Whites in all the Angles of the Field, otherways you must cause a Man to move from Angle to Angle, as you go along, with a sheet of White Paper pinn'd upon his breast.

III. Then plant your Table at R, fitting it to the Situation of the Ground, which is easily done by bear inspection, and Screw it fast; then from your first Station at R (upon the Table which represents the Place of your standing in the Field) direct your Sights to your second Station at S, and draw a line by the edge of your Index, which call your first Stationary line; then direct your Sights to all the Angles in View, as to A, ♂, ♃, ♄, drawing lines by the edge of your Index; then measure their respective distances with your Chain, from your Station-hole under the Table, hence the distance from R to A, is found 3 Poles, which take from your Scale and set from R to A; Then from R to ♂, is 5 Poles, 10 Links; from R to ♃, 6 Poles, 2 Links; and from R to ♄, 30 Poles, 4 Links: All which distances take severally from your Scale, and place them upon their respective lines; then with your Black lead-pencil draw lines from these points, *viz.* from A to ♂, from ♂ to ♃, from ♃ to ♃, so are all the Angles taken, at your First Station: But before you remove your Table, direct your Sights to the Wind-Mill at N, and draw a line at length by the edge of your Index, then take up your Table and Measure your Stationary line from R to S, which is found 104 Poles, 16 Links, which set from R to S.

IV. Plant your Table at S, laying the edge of your Index upon the edge (or close by the side) of your Stationary line, and turn the Table gently about upon the head of the Staff, till through the Sights you espie your first Station at R, there Screw it fast; then from your Stationary mark upon your Paper at S (which always

always repreſents your place of ſtanding on the Ground) direct your Sights to B (which is all the Angles in View at that Station) which diſtance on the Ground is found 3 Poles, which take from your Scale and ſet from S to B; then with your Black lead-pencil draw the line A B: Then direct your Sights to the Wind-Mill, and draw a line at length by the edge of your Index, and



where theſe two lines Interſect one another at N, there place the Mill: By which Method you may Protract any thing that's remarkable in the Ground, as Ponds, Trees, Buſhes, &c. Then direct your ſights to T your third Station, and draw a line by the edge of your Index, then take up your Table and meaſure the Stationary diſtance from S to T, which is 25 Poles, 2 Links, which take from your Scale and ſet from S to T.

V. Plant

V. Plant your Table at T, laying the edge of your Index upon the Stationary line S T, and turning the Table gently about till through the Sights you espie your Stationary mark at S, there Screw it fast; then direct your Index to all the several Angles in view, as from T to C, from T to D, from T to E, from T to F, from T to G, and from T to H; then measure these several distances upon the Ground, which several distances taken from your Scale, and prickt off from your Station at T, upon their respective lines, as from T to C, is found 9 Poles, 2 Links; from T to D, 15 Poles, 16 Links; from T to E, 15 Poles, 10 Links; from T to F, 8 Poles, 5 Links; from T, to G, 27 Poles, 2 Links; and from T to H, 29 Poles, 15 Links: Which several distances (as I said before) take from your Scale and set off upon their respective lines as here you see; then with your Black lead-Pencil draw the lines BC, CD, DE, EF, FG, and GH; which done direct your Sights to V, your fourth Station, and draw a line with your Compass-points by the edge of your Index; then take up your Table and measure your Stationary distance from T to V, which is found 55 Poles, 16 Links, which take from your Scale and and Place from T to V.

VI. Plant your Table at V, laying the edge of your Index upon your Stationary line T V, turning the Table upon the head of your Staff, till through the Sights you see your Station at T, in which posture Screw it fast; then direct your Sights from your Station at V, to all the Angles in view, as to I, K, L, M, N, and measure their distances (from your place of Standing) on the Ground, which from V to I is found 7 Poles, 16 Links, which take from your Scale and set from V to I, upon your Paper; the distance V K is found 11 Poles, 15 Links, which take from your Scale and set from V to K; likewise the line V L, is found 9 Poles, 18 Links, which set off from your Scale from V to L; then measure the distance V M on the Ground, which is 22 Poles, 10 Links, which take from your Scale and set from V to M; then measure the distance V N, which is found 25 Poles, 3 Links, which also take from your Scale and set from V to N; then take your Black lead-Pencil and draw the lines, HI, IK, KL, LM, and MN; then direct your Sights to your last Station at W, and draw a line by the edge of your Index, which done take up your Table; and the Stationary distance V W, which is found 98 Poles, take from your Scale and set from V to W.

VII. Lastly, plant your Table at W, laying the edge of your Index upon the Stationary Line V W, and turn your Table gently about till through the Sights you see your last Station at V, there screw it fast; then from your Stationary mark at W, direct your Sights to all the remaining Angles, as to O, P, Q, X, Y, and Z, which done measure each several line with your Chain upon the Ground, which from W to O, is found 21 Poles, 3 Links, which take from your Scale and set from W to O; then from W to P is 18 Poles, 10 Links, which set off by your Scale from W to P; then from W to Q, is 7 Poles 17 Links, which take from your Scale and

and ſet from W to Q; then from W to X is 12 Poles, 18 Links, which ſet from W to X; likewiſe from W to Y is 34 Poles, 17 Links, which ſet from W to Y; laſtly from W to Z, the length of the Ground-line, is found 33 Poles, 10 Links, which alſo take from your Scale, and ſet from W to Z; then with your Black-lead-Pencil draw lines from prick to prick, *viz.* from N to O, from O to P, from P to Q, from Q to X, from X to Y, from Y to Z, and from Z to ♄, which includes and compleats the whole Plot or Map of your Field as was required.

Performed another Way by the Plain-Table.

In very Irregular Grounds where you meet with the advantage of drawing long Stationary lines, you cannot ſee all the Angles from each Station, but in going on your Stationary line, all the little Crooks in the Hedge, River, Gutter, &c. may be ſeen: Therefore that you may Plot all your Angles as you meaſure on your Stationary line, obſerve this General Rule, *viz.*

A General Rule.

In going on your Stationary line, mark where an Angle falls in a Right line (or as near as you can gueſs) to your Stationary line, there plant your Table, laying your Index upon the Stationary line, and turning the Needle upon the Head of the Staff, till you either can ſee your Station you laſt came from, or that you are then going to (for you muſt always obſerve to meaſure in a ſtraight line from Station to Station (for if you ſhould any ways deviate from a Right line, it would cauſe an errour in your Work) there Screw it faſt; then obſerve how far you have meaſured on your Stationary Line, *viz.* from your laſt Station, to the place where you plant your Table; which diſtance take from your Scale and place from your laſt Station on your Stationary line, there make a prick with your Compaſs-point, and there take the Angle.

EXAMPLE.

As ſuppoſe (in the laſt Figure) you were going on your Stationary line R W, *viz.* from R to W, where the Angle ♄ we will ſuppoſe to be untaken: Now having meaſured from R on the Stationary line towards W, as far as π, being againſt the Angle at ♄, we find the diſtance R π 28 Poles, 15 Links, which take from your Scale and ſet from R to π, there make a prick; then lay your Index upon your Stationary line R W, and turn the Table about, ſo that be ſure you do not ſhake the Index off from the line, till through the Sights you eſpy either the Stationary mark at R you came from, or at W where you are going, there Screw it faſt; then from π direct your Sights to the Angle ♄, drawing a line by the edge of your Index, and meaſure the

the said distance on the Ground with your Chain, *viz.* from π to ♄, which is found 9 Poles, 16 Links, which take from your Scale with your Compasses, and set it from π to ♄.

Thus by this one example, 'tis easie to discern how the rest of the Angles (be they never so many) may be taken as you go on your several stationary lines, which is an excellent way of Plotting, where Grounds run out into many Angles or Corners, as where a Ground is bounded by a River, Watercourse, &c.

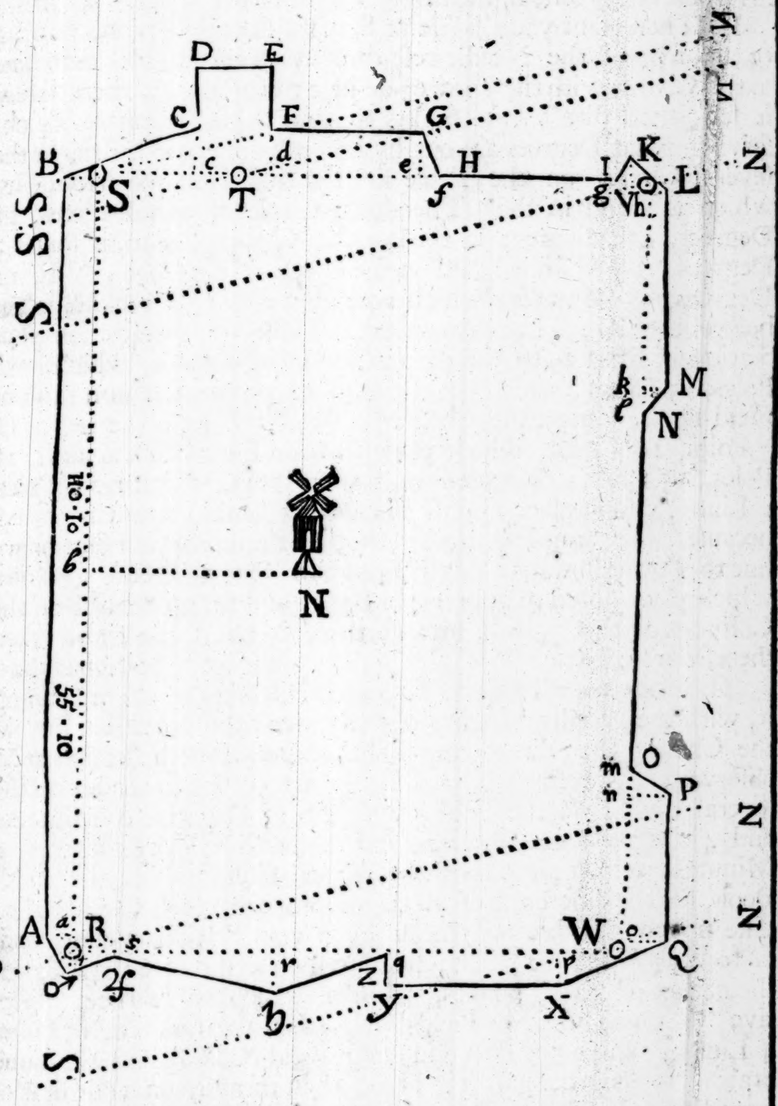
CHAP. XXIV.

How to perform the Work of the former Chapter, by the Several Circles on the Table, representing the Theodolite, Peractor, Circumferenter, *&c. all performed at one and the same time.*

THE work of this Chapter may be performed according to the directions of the 21 Chapter, by observing all the Angles at every station, with the difference of Meridians also, from all the Circles upon the Table, with the length of each Ground-line from your stations also, which inserted in your Field-Book, in the same order that is there delivered; and accordingly proceed from one station to another, till the whole work be finished, which may be Protracted on Paper by the directions in the 22 Chapter. But because this way is something too intricate and hard and would take up too much time, I shall therefore exemplifie the work of this Chapter a much easier way, and more proper to the purpose in respect of going round the Ground, but I proceed as followeth.

I. First, let Beacons be set up for your several Stations, as at R, S, T, V, W, then plant your Instrument at R (being ordered as is directed at the beginning of the 15 Chapter) with the Flower-de-luce towards you, turning the Table gently upon the head of the Staff, till the Needle hang directly over the Meridian line in the Chard, there Screw it fast, then direct your Sights to your Second Station at S, noting the Degrees cut by the edge of your Index upon the Several Circles upon the Table, which in the Circle (360) of the Theodolite is found 283 Degrees, 30 Minutes; and in the Circle of the Peractor divided into 120 Degrees, is found 94 Degrees, 30 Minutes; and in the Circle of four 90s, N W 76 Degrees, 30 Minutes, which place down in the second

second, third, and fourth Columns of your Field-Book, being the difference of Meridians observed from each Circle, then take up your Table, and begin and measure on your Stationary line from R to *a*, which is in a right line (or perpendicular) to A, 3 Poles, 8 Links, which put down in your Field-Book in the Column *Stat. Dist.* then measure the perpendicular off-set *a* A, 2 Poles, 10.



Links, to the Left-hand, which place in its proper Column in your Field-Book; then measure on your Stationary line till you come at Right Angles with the Wind-Mill at N, which from your first station R, is 55 Poles, 10 Links, which note down in your stationary Column, then the length of your Ground-line from *b* to the Mill, is 40 Poles to the Right-hand, which note

note down in its proper Column into your Field-Book, then from *b*, measure on to S, your second Station; hence the whole length of your Stationary line R S, is found 110 Poles, 10 Links, which put down in your Field-Book as before; then measure the Perpendicular off-set S B, 4 Poles, 10 Links; and note it down in its proper Collumn in your Field-Book: So is the Work on your first Stationary line finished.

II. Then plant your Table at S, your second Station, moving to and fro, till the Needle rest directly over the Meridian line in the Chard, with the Flower-de-luce towards you, there screw it fast, then direct your Sights to your third Station at T, observing what Degrees are cut by the edge of your Index, in the several Circles on the Table for the difference of Meridians, which is found in the Theodolite-Circle of 360 Degrees, 11 Degrees, 45 Minutes; in the Peractor-Circle of 120, is found 3 Degrees, 55 Minutes; and in the Circle of four 90s, N E, 11 Degrees, 45 Minutes; which note down in your Field-Book as before directed: Then take up your Table and measure on your Stationary from S, to the perpendicular off-set at *c*, which is 18 Poles, 15 Links, which put down in its proper Column in your Field-Book; then measure the Perpendicular off-set to the Left, *c* C, 7 Poles, 10 Links, which place in your Field-Book against 18 Poles, 15 Links; then measure from *c* to D, which is 15 Poles, 2 Links, which place against 18 Poles, 15 Links, again repeated, because 'tis the same length; then measure the rest of your Stationary line to T, which whole length from S to T, is 24 Poles, 5 Links, which place down in your Field-Book, and fill up the rest of the Columns with Cyphers, because there is no Angle to be taken therefrom; so is your Work finished on your second Stationary line.

III. Plant your Table at T, your third Station, there fastning it, with the Needle hanging directly over the Meridian line in the Chard; then direct your Sights to your fourth Station at V, observing (as before) what Degrees are cut by the Index on the several Circles on the Table, which is 13 Degrees, 0 Minutes; and 4 Degrees, 20 Minutes, and likewise N E, 13 Degrees, 0 Minutes; which place in their proper Columns in your Field-Book, for the difference of Meridians proper to each Circle; then take up your Table and measure on your Stationary line from T to *d*, 5 Poles, 10 Links; from which *d* measure the Perpendicular set-off to F, 7 Poles, 5 Links, which put in their respective Columns in your Field-Book; then measure *d* E, 15 Poles, 4 Links, which put down in your Field-Book against the same Stationary length, again repeated; then measure on your Stationary line as far as *e*, (where the next perpendicular off-set falls) 26 Poles, 10 Links, and measure *e* G the off-set, 6 Poles, 5 Links; which lengths put into your Field-Book in their own Columns: Then measure on to *f*, which from your Station at T, is found 29 Poles, 12 Links, where it touches the Fence, being called a Tangent line, which length put down in your Stationary Column, filling up the other Columns with Cyphers, because there is

is no distance to set off; then measure on your Stationary Line to *g*, which from T is 55 Poles, 5 Links, which place in its own Column, with Cyphers in the other Columns of your Field-Book, for the reason just before given; then continue measuring on your Stationary line to *h*, which from T is found 56 Poles, 17 Links; then measure *h* K, the perpendicular off-set, 3 Poles, 18 Links, all which put down in the respective Columns in your Field-Book; then measure on to your Station at V, being the whole length of your Stationary T V, 59 Poles, 7 Links, which put down in its proper Column; and since there is no Perpendicular Angle to take from it, put Cyphers in the other Columns, so is the work of your third Station finished.

IV. Plant your Table at your fourth Station at V, so that the Needle hang directly over the Meridian line, where screw it fast; Then direct your Sights to your fifth Station at W, observing the Index to cut the Degrees in the several Circles, as your Field-Book directs, for the difference of Meridians proper to each Circle; then take up your Table, and measure from your Station at V to *i*, 1 Pole, 10 Links; Measure also the perpendicular distance *i* L, 1 Pole, 18 Links; which numbers place down in your Field-Book according to the aforegoing directions; then measure on to *k*, 29 Poles, 14 Links, and the perpendicular distance *k* M, 3 Poles, 1 Link, which place in your Field-Book; then measure on to *l* 33 Poles, 8 Links, which put down in your Field-Book in its proper place, and because it is a Tangent line, fill up the other Columns with Cyphers; then measure on to *m*, 85 Poles, 5 Links, being a Tangent line, therefore put down 85 Poles, 5 Links, in its own Column, and Cyphers in the rest; then measure on to *n*, 89 Poles, 6 Links, and also *n* P, the Perpendicular distance or off-set, 6 Poles, 4 Links, both which Numbers transferr into your Field-Book; then measure on to *o*, 110 Poles, 10 Links, and the Perpendicular off-set *o* Q, 6 Poles, which insert also into your Field-Book; then measure on to W (being the whole length of your Stationary-line V W) 111 Poles, 13 Links, which place in its proper Column in your Field-Book; which compleats the Work of your fourth Station.

V. Plant your Table fast at W, with the Needle over the Meridian line in the Chard, then direct your Sights to R, your first Station, where the edge of your Index cuts 193 Degrees, 30 Minutes, in the Circle of 360; and 64 Degrees, 30 Minutes, in the Circle of 120; and S W, 13 Degrees, 30 Minutes, in the Circle of four 90s: This done, take up your Table and measure to the first off-set at *p*, 8 Poles, 15 Links, and the off-set *p* X, 4 Poles, and place them down in your Field-Book; then measure on to *q* 34 Poles, 10 Links, it being a Tangent put it down, and Cyphers in the other Columns; then measure the off-set *q* Y, 4 Poles, 2 Links, which place in its proper Column, against 34 Poles, 10 Links, again repeated; then measure to *r*, 52 Poles, and likewise measure the off-set *r* b, 4 Poles, 18 Links, which transfer into your Field-Book; then measure to *z* 73 Poles, 6 Links,

 which

which note down in its own Column, with Cyphers in the rest; lastly measure to the Station R, where you began, whose length W R, is 79 Poles, 5 Links, which note down as in all the examples is directed, with the perpendicular off-set R δ 2 Poles, 3 Links, which concludes the whole work in the Field-Book, as well as in the Field.

Thus 'tis easie to perceive also how any remarkable objects of Note may be taken in order to Protraction, as Gates, Stiles, Trees, Bushes, Ponds, *&c.* either to the Right or Left.

The Field-Book.

Stations.	Circ. 360		Circ. 120		Circ. four 90s.			Per. Set.		Per. Set.		Pol. Lin.	
	D.	M.	D.	M.	Coast.	D.	M.	P. *Left.*	L.	P. *R.*	L.	Stat.	Dist.
1. Stat. R.	283	30	94	30	NW.	76	30	2	10	0	0	3	8
								0	0	40	0	55	10
								4	10	0	0	110	10
2. Stat. S.	11	45	3	55	NE.	11	45	7	10	0	0	18	15
								15	2	0	0	18	15
								0	0	0	0	24	5
3. Station. T.	13	0	4	20	NE	13	0	7	5	0	0	5	10
								15	4	0	0	5	10
								6	5	0	0	26	10
								0	0	0	0	29	12
								0	0	0	0	55	5
								3	18	0	0	56	17
								0	0	0	0	59	7
4. Station. V.	104	0	34	40	SE.	76	0	1	18	0	0	1	10
								3	1	0	0	29	14
								0	0	0	0	33	8
								0	0	0	0	85	5
								6	4	0	0	89	6
								6	0	0	0	110	10
								0	0	0	0	111	13
5. Station. W.	193	30	64	30	SW.	13	30	4	0	0	0	8	15
								0	0	0	0	34	10
								4	2	0	0	34	10
								4	18	0	0	52	0
								0	0	0	0	73	6
								2	3	0	0	79	5

Note that for the proving your Field-work to be exactly taken, follows hereafter in a Chapter for that purpose.

CHAP.

CHAP. XXV.

How to Protract, or lay down upon Paper the Work of the former Chapter two several ways; First by a Scale of Chords; and Secondly by your Protractor, by the help of your Decimal Scale and Field-Book.

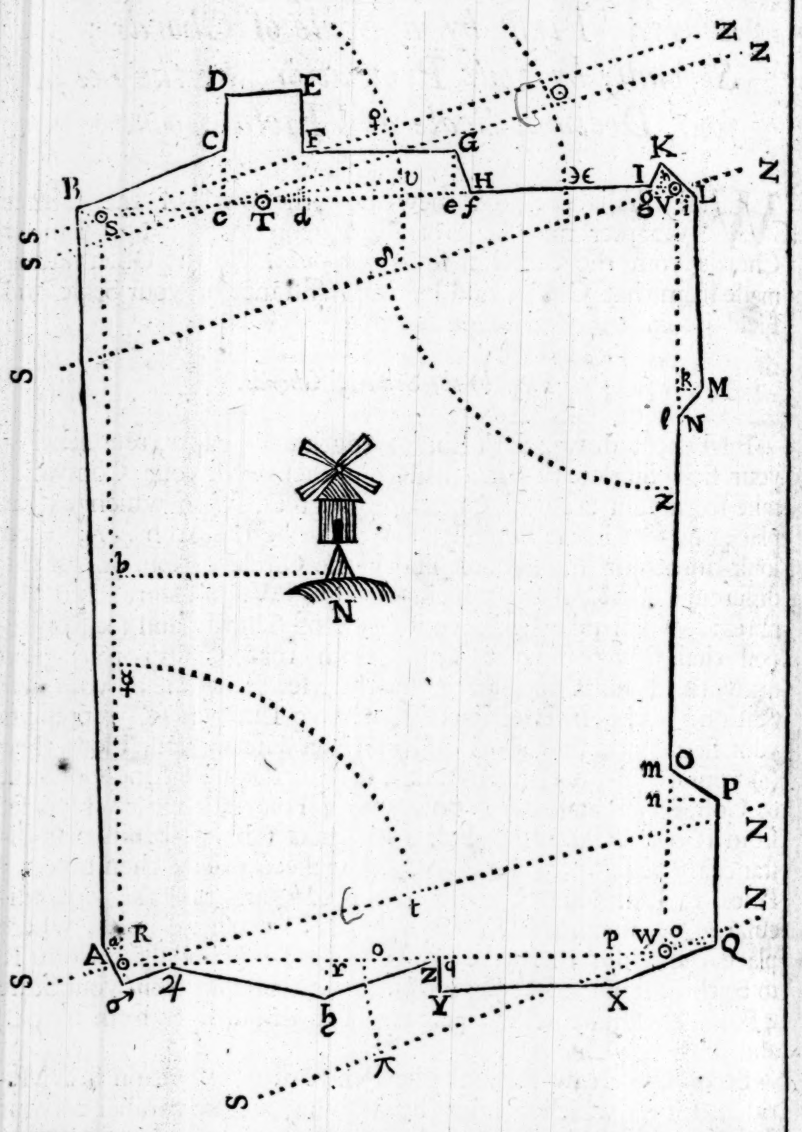
WE shall here first shew how the work of the former Chapter may be Protracted upon Paper, by a Line of Chords from the Circle of four 90s, *viz.* By the Observations made from that Circle, and by the Assistance of your Scale and Field-Book.

First by the Scale of Chords.

First then, draw a dark Line at length upon Paper, representing your first Stationary Line, as R S; then with your Compasses take from your Scale of Chords 60 Degrees, with which extent place one foot in the Point R, and describe the Arch ☿ *t*; then look into your Field-Book under the Circle of four 90s for the difference of Meridians, which is found NW. 76 Degrees, 30 Minutes; which take from your Scale of Chords, and set from ☿ (off that way to lay the Angle upon that Coast) to *t*, and draw the Line R *t* at length, for the Meridian Line of your first Station; The intersection of these two Lines at R, represents your first Station in the Field, and likewise of your Plot; then (as your Field-Book directs) take out of the Pole-Line-Column, or Column of Stationary distances, 3 Poles 8 Links, which set from R to *a*; take also 2 Poles, 10 Links (the perpendicular distance) and set from *a* to A, where make a prick; then take 55 Poles, 10 Links, and set them from R to *b*, and raise the perpendicular *b* N, upon which, from *b* to N set off 40 Poles, where place the Mill; then take 110 Poles 10 Links and set it from R to S, the distance of those two Stations; then take from your Scale 4 Poles, 10 Links, which perpendicular distance set from S to B, and draw the Line A B.

Secondly, Draw through the Centre of your Station S, a Meridian Line, which is done by drawing a Line parallel to your first Meridian; then take 60 Degrees from your Scale of Chords, setting one foot in S, and with the other make the Arch ♀ *v*; then from your Meridian Line at ♀, set off the difference of Meridians (as your Field-Book directs) 11 Degrees, 45 Minutes NE. from ♀ to *v*; then from S draw your second Stationary Line as S T; then (according to your Field-Book) take 18 Poles, 15 Links,

Links from your Scale, and ſet it from S to *c*; then ſet it off from *c* to C, 7 Poles, 10 Links, where make a prick; again, upon the ſame perpendicular Line ſet off 15 Poles, 2 Links, where make a prick; then draw the Lines from theſe pricks, *viz.* From B to C, and from C to D; then by your Scale ſet off 24 Poles, 5 Links, from S to T, being the whole length of your Stationary Line.



Thirdly, Draw again through you firſt Station T, another Meridian Line, as before directed; which done take (as before) 60 Degrees from your Scale of Chords, and make the Arch ☉ ♓; then by the help of your Field-Book, take from your Scale of Chords the difference of Meridians, (at that Station) 13 Degrees, and ſet it from ☉ to ♓, and draw that Stationary Line T ♓, at

at length; then take 5 Poles, 10 Links, and set it from T to *d*; then take 7 Poles, 5 Links, and set from *d* to F, where make a prick; then take 15 Poles, 4 Links from *d* to E, where make a prick also; then take 26 Poles, 10 Links, and set it from T to *e*; then take the off-set, 6 Poles, 5 Links, and set it from *e* to G, where make a prick; then take 29 Degrees, 12 Links, and set it from T to *f*, where make a prick; likewise take 55 Poles, 5 Links, and set it from T to L, where also make a prick; then take 56 Poles, 17 Links, and place 'em from T to *h*; then set off the perpendicular distance 3 Poles, 18 Links, from *h* to K; then set off 59 Poles, 7 Links, (your whole Stationary Line) from T to V; then draw Lines from the several Pricks, being the extent of the perpendicular off-sets, as from D to E, from E to F, from F to G, from G to H, from H to I, and from I to K; which concludes the Work of, or upon your Stationary Line T V.

Fourthly, Then through the Centre of your 4th Station at V, draw a parallel Line to any of your other Meridian Lines, which shall be your Meridian Line for that Station; then with 60 Degrees from your Scale of Chords, with one foot in the Station V, describe the Arch δ *z*; then from your Meridian at δ, set off the difference of Meridians SE, 76 Degrees to *z*, and draw the Line V *z* at length, for your 4th Stationary Line; then as before, set off all the off-sets by your Scale, as your Field-Book directs; and the length of your Stationary Line V W also, and draw Lines as before from prick to prick, *viz.* from K to L, from L to M, and so on to Q; which concludes the Work on that Stationary Line.

Fifthly, Draw a Meridian Line through the Centre of your last Station at W, then take (the common Radius) 60 Degrees from your Line of Chords, with one foot of the Compasses in W, describe the Arch π *o*; then by your Field-Book the difference of Meridians is SW, 13 Degrees, 30 Minutes, which set from π to *o*, and draw the Line W *o* at length: Now if this Line intersect your first Station at R, your Work may be well protracted, therwise not; then by the help of your Field-Book, Scale, Compasses, prick off the distances against each off-set upon your Stationary Line, and from them the perpendicular off-sets, in the same manner as before directed; and there make pricks, and draw Lines from prick to prick (as before); which includes the Plot upon your Paper as was required.

To perform the former Work by your Protractor.

Secondly by your Protractor.

First, Draw a Meridian Line upon your Paper, and make choice of some convenient place thereon, as at R, to represent your first Station; then lay the Centre of your Protractor thereon in that posture,

posture, that the Meridian Line of your Protractor may lie on the Meridian Line of your Paper; then prick off from your Protractor (from any one Circle, or from all the three Circles, which are answerable to those on the Table, which your Field-Book was made from) the difference of Meridians as your Field-Book directs, which in the Circle of 360, is 283 Degrees, 30 Minutes; and in the Circle of four 90s, the complement to that, *viz.* 76 Degrees, 30 Minutes; and in the Circle 120, is found 94 Degrees, 30 Minutes, all which falls in the point ☿; then draw the Line R ☿ at length, for your first Stationary Line; upon which set off, by the help of your Field-Book, Scale and Compasses, the several Stationary distances to the perpendicular offsets, with the off-sets also, according to the directions in the former part of this Chapter, with the whole length of the Stationary Line from R to S also.

Secondly, From the Stationary point S, draw a Meridian Line parallel to the former, upon which Stationary point, place the Centre of your Protractor, with its Meridian Line directly lying upon the Meridian Line of your Paper; then, as your Field-Book directs, prick off from your Protractor the difference of Meridians (if you will) from each Circle, which is 11 Degrees, 45 Minutes, or 3 Degrees, 55 Minutes, or in the four 90s, 11 Degrees, 45 Minutes, which falls by the edge of your Protractor from these several Circles in the point *v*; then draw the Line S *v*, at length for your second Stationary Line; upon which, as your Field-Book directs, set off by your Scale and Compasses the several Stationary lengths and perpendicular off-sets, according to the preceding part of this Chapter, as also the length of the Stationary Line S T.

According to which Method proceed with the rest of the Angles; and lastly draw the Lines from prick to prick, as from A to B, from B to C, and from C to D, &c. which shall include your Plot upon Paper, as was required.

CHAP.

CHAP. XXVI.

To perform the Field-Work of the XXVI*th Chapter, by using the Instrument as a* Circumferenter, Chard, *and* Needle; *with brief Directions to perform the Field-Work a more easie and readier way.*

TO perform the Field-work by using the Instrument as a Circumferenter, *&c.* consult Chapter 18; for when the Sights are fixed upon the Table, as the 7th Chapter directs, the Angles (by turning the Table upon the Staff) are made and observed by the Needle upon the several Circles on the Chard; as by the Theodolite and Peractor they were observed, by the edge of the Index upon the Table; so that it will be but time lost to explain this further, for your Field-Book will appear in all respects the same, and consequently the work of Protraction.

To Perform the Work of the former Chapters another way.

And because I would not be too tedious, I shall here briefly exhibit another method to peform the Field-work of this and the former Chapters; which is by planting your Table in every Angle of the said Field, and by directing your Sights from Angle to Angle, observing the Degrees made at each Angle; which with the length of the Ground-Line insert in your Field-Book; thus proceeding round the Field from Angle to Angle till the whole be finished.

EXAMPLE.

As suppose (from any of the three last Figures) you plant your Table first in the very Angle A, in the extream part of the Fence, in the same order as before is taught; directing your Sights to B, observing the Angle there made, and the length of the Ground-Line A B, both which put down in your Field-Book; then plant your Table at B (as before) and direct your Sights to the Angle C, observing the number of Degrees made at that Angle; which with the measure of the Ground-Line B C, transfer into your Field-Book; then Plant your Table at C, and direct your Sights to D, and proceed as before, and so consequently from Angle to Angle till the Work be finished.

And here Note, I cannot but highly recommend this way, only one Inconvenience attends it, and that is, when your Table is planted in the very Angle of any Field, it will be a hard mat-

matter to see the next Angle, so as to direct your Sights thereto, in respect of the Boughs of the Hedge, that generally obscure the Sight. But when you have the advantage of seeing and directing your Sights from Angle to Angle, I advise to make use of this way, when the Instrument is used as a Theodolite, Peractor, and Circumferenter.

☞ *Note*, Thus have I shewed how to take the Plot of any Ground as at many Stations, as need requires, by the Instrument as a Plain-Table, Theodolite, Peractor, and Circumferenter, in respect my Surveyor may (through custom) have more respect for some one of these Instruments (comprised on this Table) than another, till he be convinced of the necessity of all of them, which one time or another will more naturally perform the Work than another, *& contra*.

Hence I shall proceed Methodically (according to my promise) shewing the nature of plotting all manner of Inclosures, as Lordships, with the Township included, as also the Inclosing of open Fields, the plotting of Woods, Parks, Chases, Rivers, Roads, and whatever else is necessary to be known, or done in the Practice of Surveying by that way, from this Table as is most natural and agreeable to the several Cases as may happen in practice, as you will find them exemplified in the following Chapters.

CHAP. XXVII.

How to take the true Plot of a Lordship, with the Township included, and to express it upon Paper, in the same Order, Form and Quantity it lyeth in the Field.

IN taking the Plot of a Lordship, Authors have described several Methods in their particular proceedings, which I shall not here trouble the Reader with, but briefly exhibit That which by long experience find I to be the best, tying none to the strict observation thereof till their Experience is able to convince them, or their Reason free to admit; And in order to this my Assertion I shall first lay down some general Rules or Directions, and then proceed to the particular exemplification thereof.

I. Walk over the Lordship two or three times, till you can bear the Map thereof in your head, that you may the better conceive to carry on the whole Work, and to make choice of the fittest places for your Stations.

II. Plot your Township first, beginning in the most conveni-

ent

ent place to make your first Station as long as possible you can; and likewise from your mean Stations where the Houses, Homsteads, &c. stands close, make little inner Stations, taking therefrom all Out-Houses, Orchards, Yards, and little intermediate Offices, and returning to your mean Station again, observe this General Rule: Where you cannot from your mean Station see all the Angles, or backsides near Joining thereupon, to make inner Stations as before, and to perform the Work of each mean Station with inner Stations (if need requires) till the Township be finished

III. Where you conclude your Township (if your Table will bear it) from your last mean Station direct your Sights to a Station in some convenient place of the adjoining Field, so may you take the Plot thereof from as many Stations as need requires, so will such Grounds be joined to the Township, and so may you proceed with the next adjoining Ground, and so on as far as the Table will bear.

IV. Your Township being (by the preceding Rules) compleated upon your Table, with as many of the adjoining Grounds, as will come thereupon, make marks upon your Plot as you proceeded with your Work where the next Ground joins or falls upon those Fences you have already Plotted, that you may know, when you have taken the Plot of the several Fields or inclosures joining upon your former Plot, how to join them thereto.

V. Proceed where you left off, and take as many of the Inclosures upon your Table as it will bear, and joyn them to their former work, by the directions of the marks before mentioned; and in this order proceed till the whole Lordship be finished, observing to describe upon your Plot, all Roads, Foot-ways, Gates, Stiles, Trees, Mills, Mountains, Rivers, Bridges, Ponds, Lakes, and whatever is remarkable that you meet with in your Way.

VI. Observe to place the Trees, in each Hedge-Row into the Ground the Fences properly belong to; so that the Landlord, or Owner thereof may know by inspecting the Map what Fences belong to each Ground: I shall here explain these Rules in part of the Lordship of *Belton* in *Lincolnshire*, by Me Actually performed in the Year 1690 for the Honourable Sr. *John Brownlowe* Baronet, and Member of this present Parliament.

The aforegoing Rules or Directions exemplified.

Having set up your Beacons or Station-Marks in the most convenient places, as they are here expressed in the Map, where observe that the mean Stations are gradually numbered as you are to proceed with them, as 1, 2, 3, 4, 5, *&c.* that is, your First, Second, Third, Fourth, Fifth Station, and your inner Stations with Letters, as A, B, C, *&c.* to proceed then,

I. Plant your Table at 1, or first Station, and your Sights to all the Angles and places of Note observable in your Sight, and with your Chain, measure each distance on the Ground, as

to *a b* and *c*, and with the help of your Scale and Compasses, prick off (from your Station) those distances upon the Paper of your Table; then before you proceed to your second mean Station, direct your Sights through the Gate, to the inner Station at A, noting as you go along the meeting Fences, *o o*, and *o o*; then plant your Table at A, and direct your Sights to all the Angles in view, as to *d*, *o*, *f*, and *g*, and measure each length upon the Ground; then by your Scale and Compasses lay them down upon your Paper, drawing lines from prick to prick: Then direct to your second inner Station at B, and there take the Hall and the Courts in the same order before mentioned; Then repair to your first Station again, planting your Table in the same order as it was at first, and direct your Sights to your third inner Station at C, from whence as before, observe and lay down all Angles in Sight from that Station; so have you finished the Work at your first mean Station: But before you remove your Table direct your Sights to your second mean Station, striking a line by the edge of your Index for your mean Stationary line.

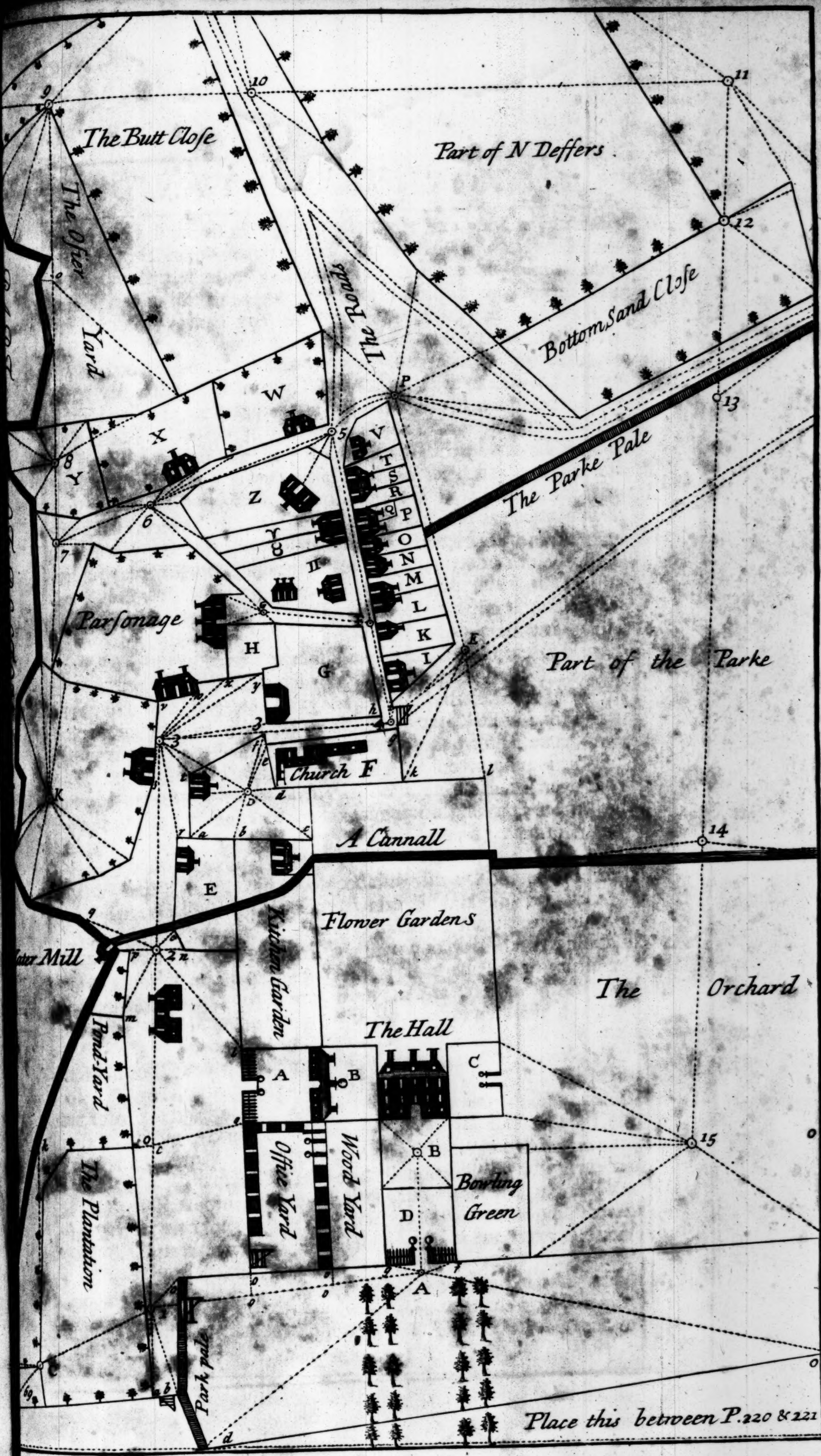
II. Take up your Table and measure from your first Station on the Stationary line, to your second mean Station, and in your way, take the Angles, *o o*, and *o o*, and lay down the measure of your Stationary distance, *viz.* from 1 to 2, there plant your Table and proceed in all respects as in the work of your first Station, observing all the Angles, Houses, Streets, and what ever is within your view; then direct your Sights to your third mean Station, drawing a line by the edge of your Index for your Stationary line.

III. Take up your Table and measure the Stationary distance from 2 to 3, and lay that distance down upon your Paper, where plant your Table and take down (as before) all that is observable in your view; from which Station make an inner Station at D, and observe and lay down all the Angles, and places of remark therefrom upon Paper: So have you finished the Work at your third mean Station; and in this order may you proceed from one Station to another (as the work or plot here will sufficiently inform you) till the whole Township be finished.

IV. *Note*, Your Township being finished at your Eighth Station, direct your Sights therefrom into the further Angle of the Close, call'd the *Osier-Yard*, to the Ninth Station, and so proceed to take the Plot thereof; then proceed from one Ground to another Joyning to the Township, as the Plot hereof, better than many words, will by inspection inform you.

V. Having thus Plotted the Township with the several Inclosures thereto adjoyning, as the Map directs; then in order to the carrying on your Work, proceed (having your Table covered with with a fair sheet of Paper) accordingly with the rest of the adjoyning Grounds, which joyn to the former in their proper places, according to the directions aforegoing; by which method you see 'tis easy to take the exact Plot of the whole Lordship.

VI. For



Place this between P. 220 & 221

VI. For the further accomplishment of the Work, observe to express the just number of Acres, Roods, and Perches in each Ground, with the name it is called by; and in the Town where the Yards, Orchards, and Homesteads are small, Notifie them with Capital Letters; then Collect them into a Table, with the the Names of the Tenants so inhabiting; that the true quantity of each particular Homestead may appear, for the further satisfaction of the Landlord or Owner.

VII. Observe also what Lordships border upon the Lordship you are then Measuring, and take the Plot of, and where each Lordship terminates; where make Marks of distinction, and on the verge of your Plot betwixt the Marks of distinction of each Lordship so bounding, write, *Part of such a Lordship*, and consequently of all others that border upon it.

VIII. In your fair Draught, in some vacant place without the verge of your Plot, make several Square, Round, or Elliptical Tables, to contain an Epitomie of the whole Lordship, *viz.* The Names and Quaintity of every particular Ground; observe also to place the Fly in some convenient place thereof, to shew the Situation, or point of bearing; not forgetting to Beautifie your Map with the Coat of Arms belonging to the Landlord, or Owner thereof.

The aforegoing Rules or Directions, well understood, are sufficient to perform the Plotting of any Lordship whatsoever.

CHAP. XXVIII.

The true Method of taking a Plot of Uneven, Hilly, or Mountainous Grounds, in respect of their true Quantity, and otherways, by the Plain-Table.

ALL Authors I have yet met with, are very Lame and Deficient in this particular; all that I find they take notice of, is to find the Quantity of the Hypothenuse and Horizontal Line of any Hill, and so resolve it as a Triangle for to find the quantity thereof, or by measuring the Diagonal of a Hill; in which 'tis observable, they all take it for granted, that the Hills are always of a Regular Form, all sides of one length, and stand upon a Horizontal bottom; otherways their Rules are defective and will not do: But this seldom or never happens in any Grounds, for it is certain in all Hilly Grounds, that the Hills are some higher, some lower, and of various irregular forms, or joyning or running confusedly one Hill into another; some near the top, some

ſome nearer the bottom, making ſeveral little Planes and Valleys betwixt them. This material caſe wants Explaining, and Rules to perform it by, which I ſhall here furniſh my Surveyor with; which are briefly in two reſpects: The firſt is, For to take the true Plot thereof that ſhall expreſs the true quantity of the ſaid Ground in Acres. The ſecond is, To take the Plot thereof as a Plain and Even Ground, by going about the outſides thereof; which way of Plotting is nothing different from the Work of the Twenty Third Chapter: The Map thus taken is to be joined to the Plot of your Lordſhip, in reſpect the greateſt part of the Lordſhip conſiſts of Plain and Even Grounds; in which Map you are to expreſs all the ſeveral Hills as they lie in the Ground by ſhadowing them with your Pencil upon your Paper; ſo I proceed to explain the Rules by an Example for the Plotting a Hilly Ground that ſhall expreſs the true quantity thereof.

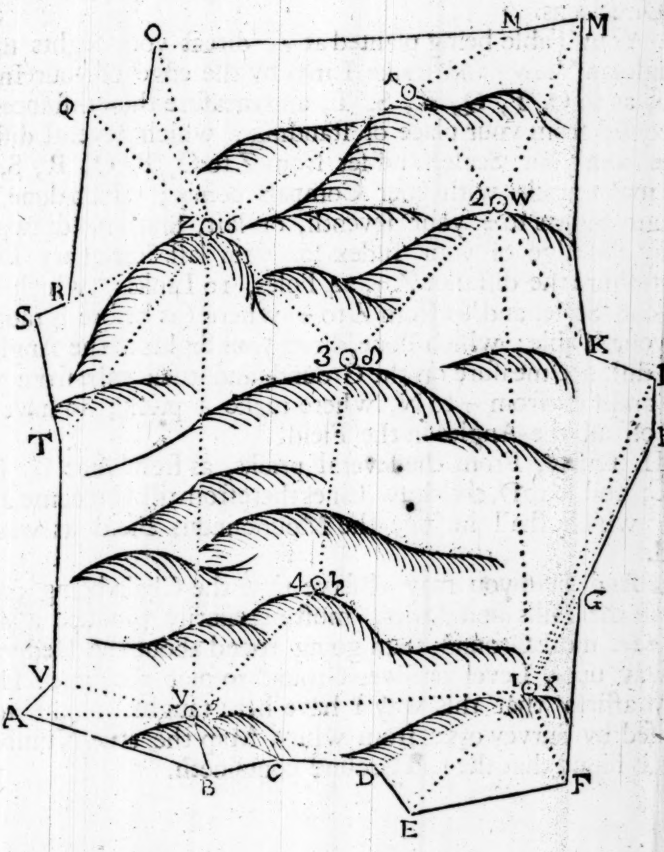
I. In a Ground where there are Multiplicity of Hills running one into another irregularly or confuſedly, place Beacons on the top of ſeveral of the higheſt or moſt material Hills, whither you can ſee the Angles in the Hedges, or Hedges themſelves from ſeveral of the ſaid Hills, it matters not; and direct your Sights from Station to Station, laying down each Stationary Diſtance upon your Paper from your Scale; placing your Beacons or Station-Marks ſo, that your Chain in meaſuring theſe Stationary diſtances, and ſo on to other Stations, where the Hedges may be ſeen, may paſs over all the (or the moſt material) Hills in the Ground, as we ſhall here demonſtrate.

II. Admit the Figure Noted with A, B, C, D, E, F, *&c.* be a Hilly Ground to be Plotted, whoſe juſt number of Acres is required; ſet up Beacons or Stationary Marks upon the tops of moſt of the material Hills, as at X, W, ♂, ♄, Y, Z, π.

III. Plant your Table at X, your firſt Station, directing your Sights therefrom to the Angle D; then with your Chain, meaſure the diſtance X D on the Ground, which is found 18 Poles, 15 Links, which take from your Scale and ſet from X to D, where make a prick; then direct your Sights to E, whoſe diſtance from X is found on the Ground 18 Poles, 8 Links, which take from your Scale, and prick off from X to E; then direct your Sights to F, whoſe Ground Line is found 10 Pole, which prick off from X to F, on your Paper; then again direct your Sights to G and H, whoſe Ground-Lines are found 9 Poles, 15 Links, and 29 Poles, 16 Links, which (with your Scale and Compaſſes) ſet off upon your Paper; ſo have you finiſhed the Work of your firſt Station.

IV. Direct (before you alter your Table as it ſtands planted at your firſt Station) your Sights to your ſecond Station at W, drawing your Stationary Line by the edge of your Index, and meaſure the length of the ſaid Stationary on the Ground, which is 52 Poles, 10 Links, which take from your Scale, and ſet it from X to W, where place down your Table, laying the edge of your Index upon the Stationary Line X W; your Index reſting in this poſture,

posture, turn the Table gently upon the head of the three-legged Staff, till through the Sights you espie your first Station-mark at X, where screw it fast; then direct your Sights to all the several Angles in view, as to K, L, M, and measure their several distances from your Station at W, as W K, 18 Poles, 5 Links, and W L, 10 Poles, and W M, 21 Poles, 15 Links; which several distances take from your Scale, and prick them off upon their Respective Lines upon your Paper.



V. Then (as before) direct your Sights to ♂ your third Station, and draw a Line by the edge of your Index; then measure on the Ground from W to ♂, which is found 23 Pol. 7 Links, which take from your Scale and set from W to ♂, where plant your Table as was directed at your last Station: Now because you cannot see the Fences in any part of the ground by reason of the Hill from this Station, therefore direct your Sights to ♄, your fourth Station, which distance ♂ ♄, measure on the Ground 23 Poles, 5 Links; which take from your Scale, and set from ♂ to ♄; where plant your Table by the former Directions, and direct your Sights to Y, your fifth Station; then measure the Stationary distance, ♄ Y, 20 Poles, which

which take from your Scale, and place from ♄ to Y, where plant your Table.

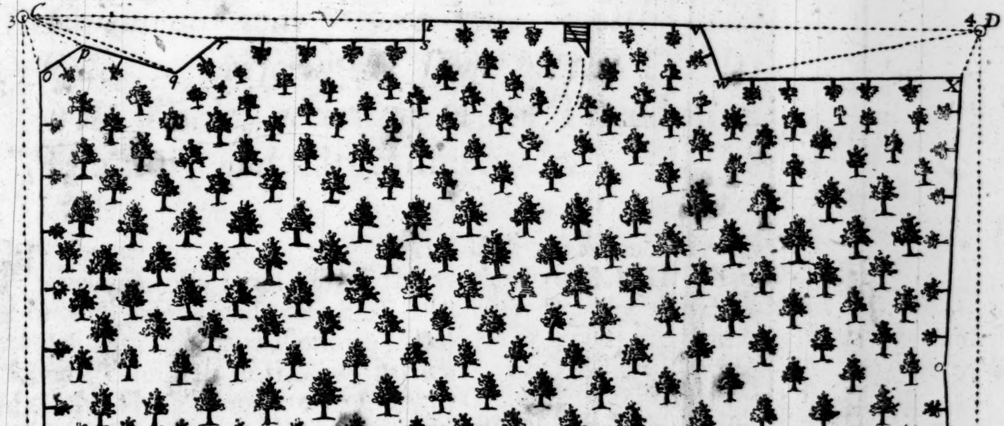
VI. Then direct your Sights from your Station at Y, and therefrom observe, measure, and lay down upon your Paper as you were directed at your first and second Stations; then direct your Sights to your sixth Station at Z, and strike a Line by the edge of your Index for your Stationary Line, whose length on the ground is found 50 Poles, 5 Links; which take from your Scale, and set from Y to Z; where plant your Table by the aforegoing Directions.

VII. Your Table being planted at Z, direct your Sights to all the Angles in View, and strike Lines by the edge of your Index thereto, as to O, P, Q, R, S, T, and measure their distances on the Ground from your place of standing; which several distances take from your Scale, and set from Z to O, P, Q, R, S, T, where make pricks with your Compass points; which done, direct your Sights to π your seventh, or last, Station, drawing a Line by the edge of your Index for your last Stationary Line; then measure the distance Z π, 24 Poles, 10 Links; which take from your Scale, and set from Z to π, where (as before is taught) plant your Table; which done, direct your Sights to the Angle N, which distance measure on the Ground, and then take from your Scale and set from π to N, where make a prick; so have you prickt off all the Angles in the Field.

VIII. Lastly, From the several pricks, as from A to B, from B to C, and so to D, *&c.* draw Lines therefrom till you come again to A, which shall include the Mountainous Field as was required.

☞ And here you may observe that the Chain being drawn over all the Hills and Dales, must necessarily produce a larger Plot, *viz.* more Ground, than going round about the Hedges all the way upon Level or Even Ground to plot the same: Hence I may affirm that this way I have here taught, ought to be practised by Surveyors; from which Map the true Number of Acres is found that the said Ground containeth.

CHAP.



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CHAP. XXIX.

How to take the Plot of a Wood or Forest by the Plain-Table, *when, by reason of the Wood growing thereon, you cannot see any convenient way before you; with brief Rules to perform the same by the Circles on the Table, according to the* Theodolite, Peractor, *and* Circumferenter.

IN the performance of this Work I shall use as much brevity as conveniently I can; for if the work of the XXIII. Chapter be well understood, this must be so likewise: For the difference of Measuring and Plotting of a Wood or Forest from other Grounds, consisteth in this one particular, *viz.* Whereas by reason of the Thick Wood growing on the Ground, you cannot see any convenient distance before you, therefore proceed on the outside, as in other Grounds you do on the inside, by setting up Station-Marks in the most convenient places in the Grounds adjoyning, and so take all the Angles from you, as the following Figure and Directions will further inform you.

EXAMPLE.

Admit the Figure Noted with the Letters, *a, b, c, d, e, f, g, h, i, k,* &c. be a Wood or Forest, whose Plot (retaining the true quantity of Acres) is required.

I. Place your Beacons or Station-marks in the adjacent Grounds round about the said Wood, as at A, B, C, and D; then plant your Table at A, and direct your Sights to all the Angles in view; as to π, *a*, *b*, and *c*, striking Lines by the edge of your Index; then with your Chain measure the length of each Line on the Ground, as from A to π, is found 16 Poles, 15 Links; which take from your Scale, and prick off upon your Paper from A to π; then from A, to *a*, on the Ground, is 2 Poles, 17 Links; which likewise take from your Scale, and set from A, to *a*, upon your Paper; then the Ground-Line A *b*, is found 11 Poles, 7 Links, which accordingly take from your Scale, and set from A to *b*; your next Ground-Line A *c*, is found 11 Poles, 12 Links, which likewise take from your Scale, and set upon your Paper from A to *c*: Thus having taken and laid down upon your Paper all the Angles in view at the first Station, direct your Sights to your second Station at B, drawing a Line by the edge of your Index; which done,

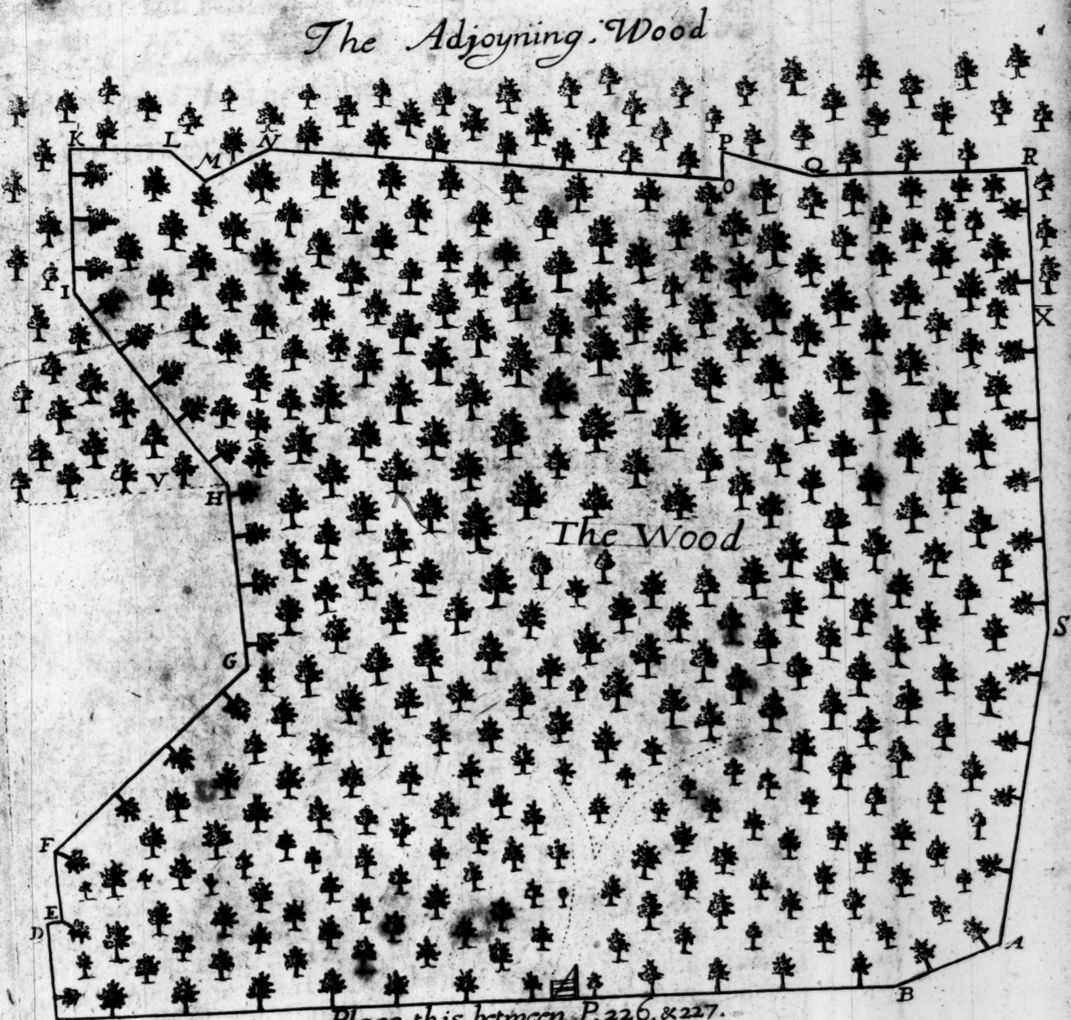
take up your Table, and with your Chain meaſure the Stationary diſtance, which is found 90 Poles, 2 Links; which take from your Scale, and ſet from A to B, where place your Table.

II. Your Table being ſet down at B, lay the edge of your Index upon the Line A B, and turning the Table upon the Head of the Staff, till through the Sights you eſpie your firſt Beacon or Station-Mark at A, there ſcrew it faſt; then direct your Sights to all the Angles in view, as to *d*, *e*, *f*; then meaſure with your Chain their lengths on the Ground, which lengths take ſeverally from your Scale, and prick them off from B to *d*, *e*, and *f*, according to the direction at you firſt Station; which done, direct your Sights to your third Station at C, drawing a Line by the edge of your Index; then take up your Table and meaſure on the Stationary Line B C, till you come at X; which diſtance take from your Scale, and ſet from B to X, where plant your Table according to the preceding Directions, directing your Sights to the Angles *g*, *h*, *i*, *k*, *l*, *m*, *n*, drawing Lines by the edge of your Index, and meaſuring their reſpective diſtances on the Ground; which ſeveral lengths take from your Scale, and ſet from X to *g*, *h*, *i*, *k*, *l*, *m*, and *n*; that done, take up your Table, and meaſure on to your third Station at C, and there proceed in all reſpects as is taught in the Work of the firſt and ſecond Station; and ſo conſequently from one Station to another till the whole Work be finiſhed; and laſtly, draw Lines from prick to prick, *viz.* from *a* to *b*, from *b* to *c*, from *c* to *d*, ſo to *e*, and ſo on till the whole Plot be included; as the Figure or Plot aforegoing, better than many Words will inform you.

Performed by the Circles on the Table.

The former Work may be as exquiſitely performed by the Circles on the Table, according to the Theodolite, Peractor, or Circumferenter; and becauſe I would not be guilty of Tautology, I refer the Reader to the XXIV. Chapter of this Book, this Work being no other than what is there plainly taught; and though in the performance hereof you go round on the outſide, as you are there directed on the inſide, yet it makes no difference in the carrying on the Work; for the Field-Book having Columns for the Set-offs both to the Right and Left, demonſtrates the Work to be performed after the ſame way; and the XXV. Chapter ſhews how to protract the Plot thereof upon Paper, as it is taken from the Circles of the Table, which being underſtood, will not need my further Explanation here.

CHAP.



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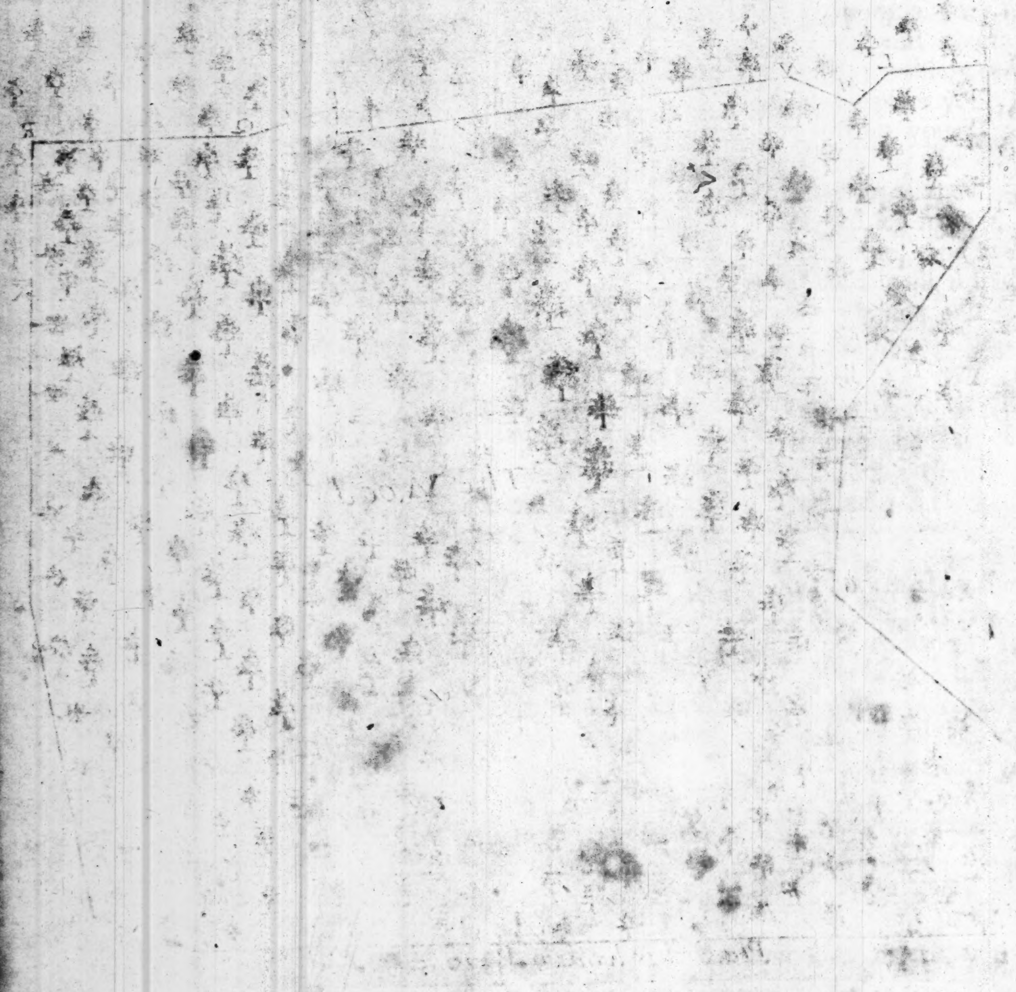


CHAP. XXX.

How to take the Plot of a Wood or Forest, which joyneth to another Wood or Forest, that you are not concerned to measure, when you cannot (by reason of the joyning of the Woods) see any convenient Way before you, by the Chard *and* Needle, *as a* Circumferenter.

TO take the Plot of a Wood or Forest that is in part bounded by another Wood or Forest, as we hinted in the XIII. Chapter of this Book, in the description of the Chard and Needle; may be performed by the Chard and Needle from the Circle of four 90s, two several ways: The first is by planting your Table near the Wood-side, and by direction of the Needle you may be able to keep a straight Line, and therefrom take the Angles either to you or from you, as the XXIV. Chapter hereof Directs. The second way is by planting your Table in every Angle, directing your Sights (as they are fixed on the Table, by turning the Table about upon the Head of the Staff) straight on the Fence or Hedge-Row; whether you can see the next Angle or no it matters not, and by observing the Angle the Needle makes with the Meridian Line, which note down in your Field-Book, with the length of each Line also: And this is the method I most approve of, and shall further Explain it by the Example or Demonstration following: And here observe to fix your Sights on the Table, as the VII. Chapter hereof directs; then suppose the following Figure Noted with the Letters A, B, C, D, E, F, G, H, I, K, L, M, N, O, P, Q, R, S, to be a Wood or Forest, which is bounded on the North-side, and on part of the East and West-side, with another Wood, which you are not concerned for, as the Lines V and X express.

I. First then, Plant your Table in the Angle A, turning it gently about upon the Head of the Staff, till you direct your Sights straight on the Hedge-Row, or Fence, to your next Angle at B, *viz.* from A to B, where screw it fast; then observe what Quadrant or Quarter of the Circle the Needle rests in, and what Degrees it there cuts; which we find SW, 47 Degrees, 30 Minutes, which put down in your Field-Book; then measure with your Chain the length of the Ground Line A B, which is found 10 Poles, 18 Links, which place down in your Field-Book also.

II. Plant your Table at B, turning it upon the Head of the Staff, directing your Sights exactly on the Fence or Hedge-Row, *viz.* from B to C, where screw it it fast, observing the Needle to rest in the N W. Quadrant, on 83 Degrees, 30 Minutes, which put down in your Field-Book; then measure with your Chain the length of the Line B C, which is found 81 Poles, 15 Links; which put down in your Field-Book also.

III. Plant your Table at C, turning it upon the Head of the Staff till you have directed your Sights on the Hedge-Row, *viz.* from C to D, screw it fast, and you'll find the Needle rests just over the Meridian Line in the Chard; for which write North and South in your Field-Book; then measure the Line C D with your Chain, whose length is found 8 Poles, 14 Links, which put down in your Field-Book also.

IV. Plant your Table at D, directing your Sights to E, where screw it fast; finding the Needle to rest NE, 76 Degrees, 30 Minutes; which put down in your Field-Book, with the length of the Line D E, 2 Poles, 8 Links also.

V. Plant your Table at E, and by turning it about, direct your Sights on the Hedge-Row to F, where screw it fast; and again you'll find the Needle to rest over the Meridian Line; hence write North and South again in your Field-Book; then measure the length of the Line E F, with your Chain, which is 6 Poles, 3 Links; which accordingly put down in your Field-Book.

VI. Plant your Table at F, directing your Sights (by turning the Table) on the Hedge-Row to G, where screw it fast; in which posture you'll find the Needle to rest upon 52 Degrees, 30 Minutes NE, which put down in your Field-Book; then measure with your Chain the length of the Fence or Hedge F G, 26 Poles, 14 Links; which transcribe into your Field-Book as before.

VII. Plant your Table at G, and, as in all the former Angles, direct your Sights on the Hedge-Row to H, where screw it fast; and finding the Needle again to rest directly over the Meridian Line, note down North and South in your Field-Book; then measure with your Chain the length of the Ground-Line G H, 17 Poles, 12 Links; which also put down in your Field-Book.

VIII. Then again plant your Table at H, where you find the other Wood begins to joyn upon you, still observing the same Method, by directing your Sights on the Fence or Hedge-Row from H to I, where screw it fast; and finding the Needle to rest over 31 Degrees, put them down in your Field-Book, with the length of the Ground-Line H I, 24 Poles, 10 Links: And in this order may you proceed from one Angle to another, till you have finished or gone round the said Wood.

The rest of the Angles are taken as the Field-Book directs, according to the aforegoing Directions, which being well understood, are sufficient to perform any thing in this Nature.

I have

I have been the larger upon this useful performance, because I have met with no Directions in any Authors to this purpose.

The Field-Book.

The		Circle four 90s.			Measure.	
Angles.		Coast.	D.	M.	P.	L.
1	A B	SW.	74	30	10	18
2	B C	NW.	83	30	81	15
3	C D	North and South.			8	14
4	D E	NE.	76	30	2	8
5	E F	North and South.			6	3
6	F G	NE.	52	30	26	14
7	G H	North and South.			17	12
8	H I	NW.	31	00	24	10
9	I K	NE.	5	00	14	5
10	K L	SE.	83	00	9	18
11	L M	SE.	38	50	4	0
12	M N	NE.	73	30	6	10
13	N O	SE.	80	30	44	5
14	O P	North and South.			2	4
15	P Q	SE.	70	20	10	5
16	Q R	SE.	85	00	20	0
17	R S	SW.	3	50	45	0
18	S A	SW.	15	30	31	7

CHAP. XXXI.

How to protract upon Paper the Work of the former Chapter.

First lay your Paper (which let be of that bigness that may contain your Plot) before you, smooth upon a Table, with your Field-Book also before you; then fixing upon some convenient place of your Paper, as at A, draw a Line at length as A *a*, for a Meridian Line, noted (as here) with North and South; then look into your Field-Book, and see which way the first Angle coasts, which is SW; Then lay the Centre of your Peractor upon A, keeping the Meridian Line of your Protractor, upon the Meridian Line of your Paper A *a*, with the Semicircle of your Protractor to the same Coast your Field-Book directs; and therefrom

from (according to the Direction of your Field-Book) prick off 74 Degrees, 30 Minutes, drawing the Line A B, which is to contain 10 Poles, 18 Links.

II. Through the point B draw another Meridian Line (which is nothing but a parallel Line to the former) as B *b*; then lay the Centre of your Protractor upon the point B, with its Semicircle towards the same Coast your Field-Book shall inform you, with the Meridian Line of your Protractor upon the Meridian Line of your Paper B *b*; then in the Field-Book, against the second Angle B, I find NW, 83 Degrees, 30 Minutes, which I prick off from the Semicircle of the Protractor, and draw the Line B C, which is to contain in length 81 Poles, 15 Links.

III. Then through the point C draw another Meridian Line as before, as C *c*, now in the Field-Bock against the Angle C, is written North and South; so that I have no more to do here, but to set the length thereon taken from your Scale, as your Field-Book directs, which is 8 Poles, 14 Links; which (as I just now said) take from your Scale, and set from C to D, and draw the Line C D.

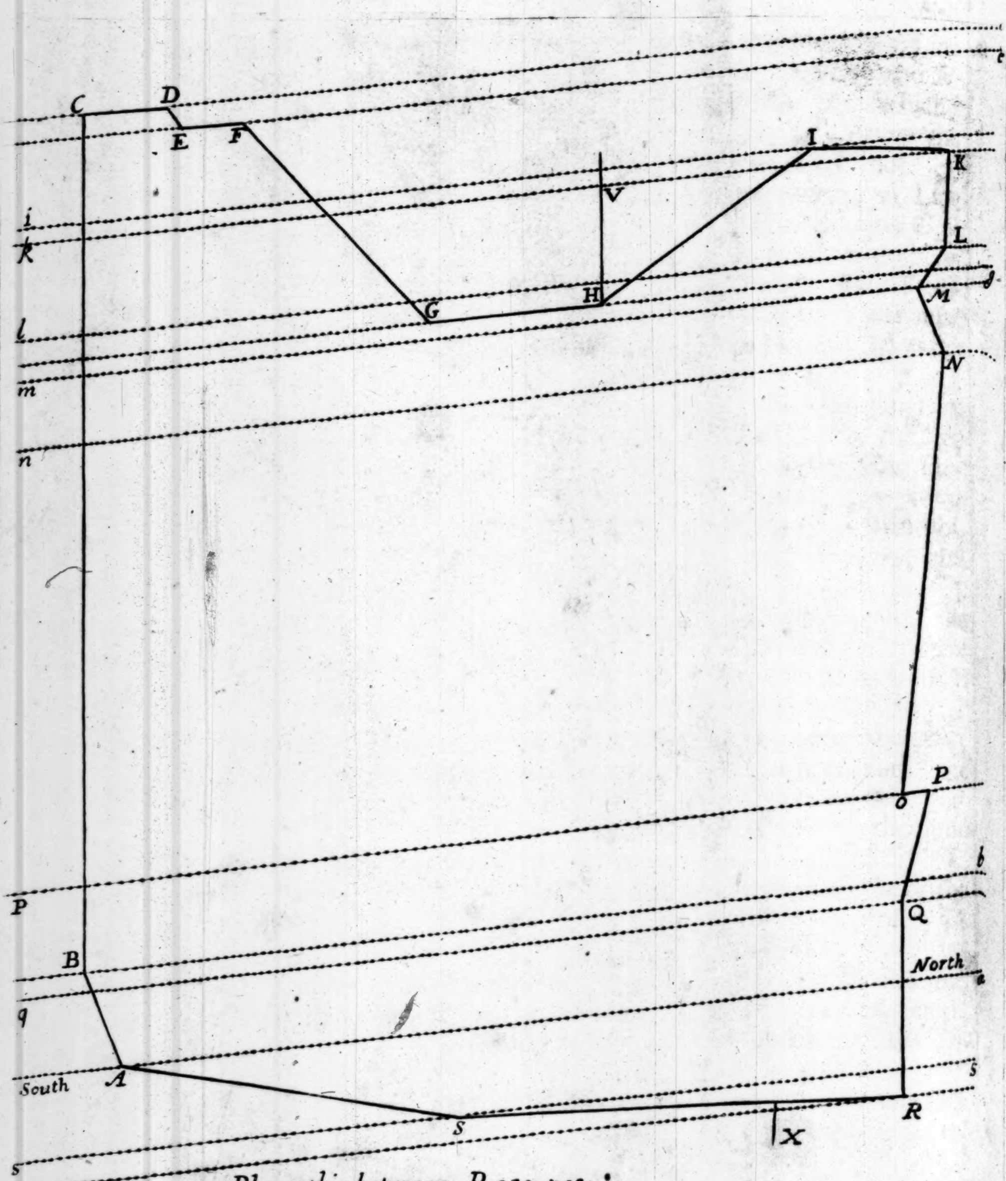
IV. Upon the Meridian Line last drawn, place the Meridian Line of the Protractor with its Centre upon the point D, and the Semicircle towards the Coast your next Angle bends to; your Protractor resting in this Posture, repair to your Field-Book, where finding against the fourth Angle D, 76 Degrees, 30 Minutes, NE, which prick off from the Semicircle of the Protractor, and draw the Line D E to contain 2 Poles, 8 Links.

V. Draw a Meridian Line through the point E, then against the fifth Angle E in the Field-Book, I find North and South; here I have only 6 Poles, 3 Links to take from my Scale and set from E to F, and draw the Line E F.

VI. Then upon the last Meridian Line E F *e*, upon the point F, I place the Centre of the Protractor, with its Meridian Line lying exactly on the Meridian Line E *e*, not forgetting the former caution of laying the Semicircle of the Protractor to the same Coast the Field-Book directs; which at the sixth Angle F, is NE, 52 Degrees, 30 Minutes, which prick off the Semicircle of the Protractor; and draw the Line F G in length 26 Poles, 14 Links, according to the direction of the Field-Book.

VII. Then through the point G, draw another Meridian Line; then repair to the Field-Book, where I find North and South, which proceed with to set off according to the third and fifth Directions.

VIII. Upon the last Meridian Line G H *g*, in the point H I, place the Centre of the Protractor, as is taught in the the fourth and sixth Directions, which I find by my Field-Book NW, 31 Degrees; which I prick off from the Centre of the Protractor and draw the Line HI, whose length I find by the Field-Book, 24 Poles, 10 Links, which I take from the Scale and set from H to I; and in this manner proceed with the rest of the Angles, till the whole Plot be protracted upon Paper: See here



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here the whole demonstration, which will further the Judgment of my Reader.

Performed another Way.

And here Note, The aforegoing Protraction might have been performed by drawing parallel Lines for Meridians at a venture, provided they had been nearer together than the length of the Scales, of equal parts, upon the sides of the Square of the Protractors; for then though you could not have had a Meridian Line in every Angle, to have laid the Meridian Line of your Protractor upon; yet by the help of those aforenamed Scales, your Protractor may be placed parallel thereto, to fit any point in the Plot; then will the Work be performed in all respects with the former.

CHAP. XXXII.

How to cast up the Content of any Field-Plot, and to find the Content thereof in Acres, Roods and Perches.

ALthough the Work of this Chapter is taught in the 17th Problem of the Second part of the Book of *Geometry*; yet we shall make it here more plain and applicable to our present purpose by the Example following.

Admit the following Figure Noted with the Letters A, B, C, D, E, F, G, H, I, be the Plot of a Field laid down from our new Scale, whose Content in Acres, Roods and Perches is required.

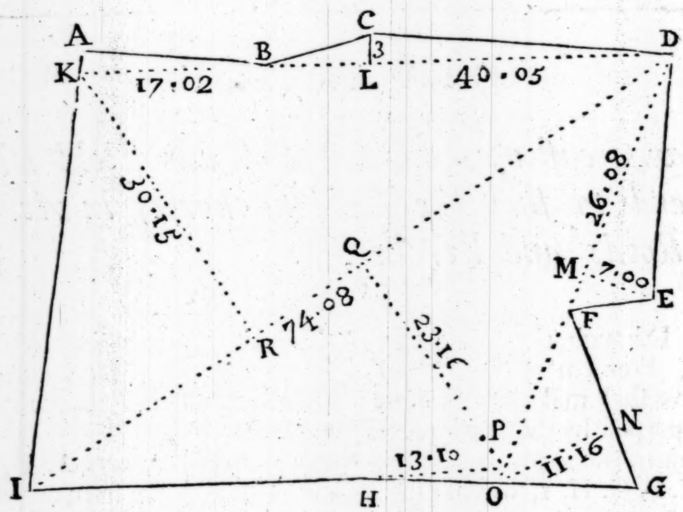
First, Then (and in all such Cases) divide your Plot into Trapezia's and Triangles; accordingly this Figure is divided into one Trapezium, as K, D, P, I, and five Triangles; for finding the Area of all which, begin with any one first, and multiply the whole of the Base by one half of the perpendicular, or (which is all one) the whole of the Perpendicular by the half of the Base; the Product eitherway is the Content of that Triangle in Perches.

EXAMPLE.

First, Measure the Trapezium K, D, P, I, by taking first the Diagonal or Base-Line, D I, into your Compasses, and applying that length to the Scale, which I find reaches 74 Poles, 8 Links; accordingly the Measure of the Perpendicular K R, is found 30 Poles, 15 Links; which added to the length of the other Perpendicular P Q, 23 Poles, 16 Links, the Summ is 54 Poles, 11 Links, or 54 Poles,

Poles, 5 Primes, 5 Seconds (as is taught in the Description and use of the Chain in the Second Chapter) which multiply into half the Base, 37 Poles, 2 Primes, gives in the Product 2019 Perches, and $\frac{26}{100}$ parts of a Perch. In the like manner in the Triangle A B K multiply 17 Poles, 1 Prime, the Base, by 1 Pole the half Perpendicular; which Product gives the Content of that Triangle 17.1; and in the same order I proceed to find the Contents of all the rest of the Triangles, which at last I collect, or add into one Sum; which is the Area or whole Content of the Field in Perches, and parts of a Perch, as it is here underneath adjusted.

And here observe the Measures of each Line are expressed upon the Plot.



			Perc.	Pts.
The Area or Content in Perches and the parts of a Perch.	Trapezium	K D P I.	2019	26
	Triangle	A B K.	17	10
	Triangle	B C D.	60	37
	Triangle	D E F.	92	30
	Triangle	F G O.	107	38
	Triangle	O H P.	6	75
The Area of the whole Field in Perches			2303	16

Then according to the Directions of the Sixth Chapter these 2303.16 Perches may be reduced into Acres according to any of the three ways there taught, which amounts to 14 Acres, 1 Rood, 23 Perches; and so much doth the former Field contain.

CHAP.

CHAP. XXXIII.

A ready and easie Way for Shifting of Paper.

IT very ordinarily falls out in practice, that your Table as it is covered with Paper is too little in several cases, especially in great Grounds, where the Lines outstrip or overrun the Table; in such a case (when you have proceeded so far till your Lines run off on the Paper or Table) you must shift your Paper, and put a fair sheet upon the Table.

First then upon your last Stationary Line which runs off on your Table, observe to shift that Sheet so far off or besides the Table, that your last Station marked thereupon may be marked just upon the Table; to which sheet (in this order) glew a fair Sheet with Mouth-glew, and so fasten them down with the frame of the Table.

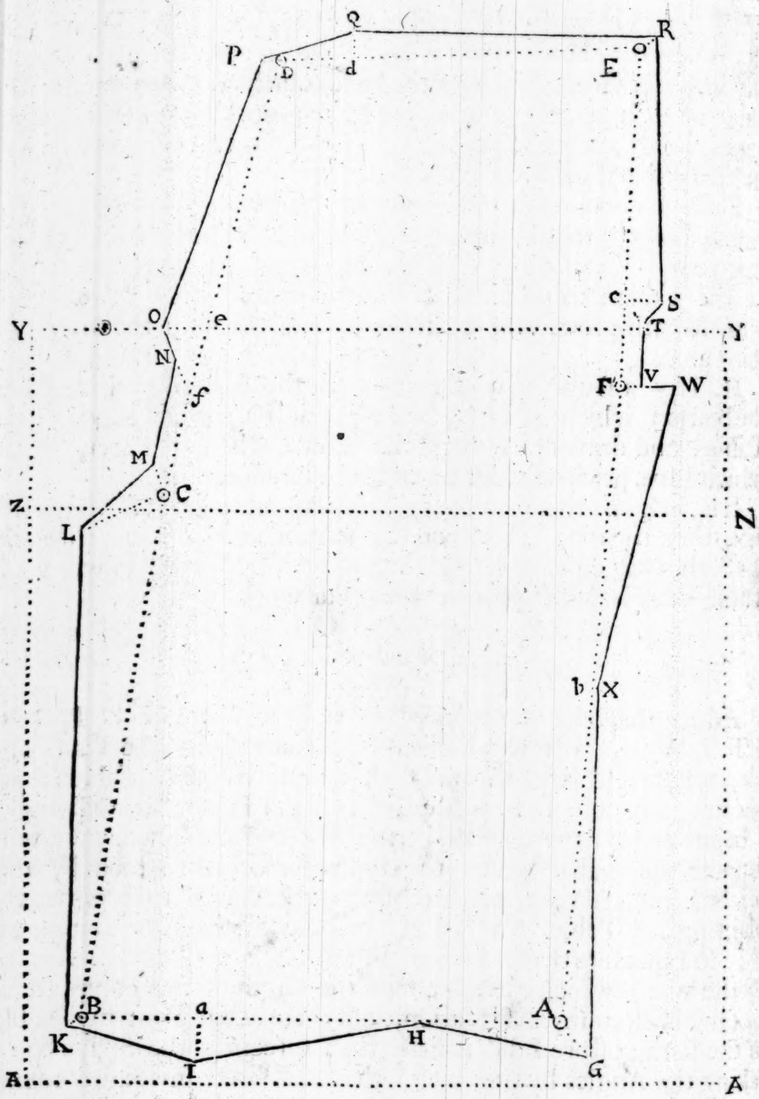
II. Lay a Rular upon that part of the Stationary Line from the Station which, as I said before, is just upon the edge of the Table, and draw or augment that Line on the fair Paper, upon which Line prick off your Stationary distance.

III. Upon this Stationary Line lay the edge of your Index, then turn the Table upon the head of the Staff till through the Sights you espie your last Station you directed to; so will your Table be rectified to proceed with your work.

EXAMPLE.

Admit the following Figure, G H I K L M N O P Q R S T V W X, represent a Field to be Plotted by the Plain-Table, which is so large it cannot all be Plotted on the Table; and because I would have as much upon the Table as it will bear, I begin as near the edge of my Table as I can; hence we will suppose the Table within the Frame to be understood by the prickt Lines, A Y, Y A, therefore I make choice to begin at A, planting my Table there, and direct my Sights to the Station at F; so I measure the Stationary distance A F (taking the Angles by the way) which extends almost the length of the Table; then I come back to my first Station, and there again plant my Table in the same posture I did at first, then directing the Sights to B, taking the Angles by the way, thence I direct my Sights to my Station at C, where I plant my Table, taking the Angles therefrom that are in view; then I direct the Sights to the Station at D, drawing a Line by the edge of my Index to the further end my Table, as C *d*, where it runs off on the Table; then because I can proceed no further before I shift my Paper, and put a clean Sheet upon the Table; I take this Sheet off, and with Mouth-

glew, I glew another ſheet to it at Y Y; then I put them both upon the Table in this order, *viz.* I bring the Station C to the Station B upon the Table, and ſo faſten them down with the Frame, ſo that the Line Z Z, poſſeſſeth the place of the Line A B, ſo that, part of your Plot is yet upon the Table, *viz.* From C to *e*,



and the reſt (being almoſt all) of the Table, being covered with fair Paper; then plant your Table again at the Station C, laying the edge of the Index upon that part of that Stationary Line which was drawn before your Paper was ſhifted, *viz.* C *e*, and extend it

it to D, upon your fair Paper, and then proceed to finiſh your Plot.

Note, There is another way to perform this Work by, *viz.* By the Scales of equal parts upon the Frame of the Table, which is taught in ſeveral Authors; ſo that I ſhall not trouble my Reader with it here, by reaſon this way I have here taught is much plainer, eaſier, and in all reſpects as exact as any way I have yet met with.

CHAP. XXXIV.

How to know whether a Plot be truly taken, and of proving the Work at every Station (as you go along) to be truly taken or not; and in caſe of Errour how to find and correct it before you be too far paſt it, taken by the Plain-Table.

FIrſt in the Plotting any Field or Ground by the Plain Table, be ſure to let your Beacon or Station-marks ſtand up in every Station-hole till you have finiſhed your Plot; and likewiſe Whites or Marks in moſt of the material Angles in the Field, all which will be of great uſe for proving the work of your Plot as you go along, or proceed with your Work; which by theſe few following Directions will inform you whether you have proceeded right or not; and in caſe of an Errour committed, how to find it where is.

II. When you are departed from your firſt Station, and have proceeded to your ſecond Station, and taken all your Angles by the way, and planted your Table at your ſecond Station, in order to proceed to your third Station; and would know whether the Work of your firſt and ſecond Station be truly taken: Direct your Sights to one or more of the moſt material Angles you took, as you proceeded from your firſt to your ſecond Station; and if the edge of your Index cut the Angles upon your Plot, your Work is ſo far, truly taken, otherwiſe not.

III. When you have planted your Table at your third Station, and taken all the Angles by the way; then direct your Sights from your firſt Station; and if you find the edge of your Index to cut your firſt Station upon your Plot, your Work is exactly performed to your Third Station, where you then are: But in caſe you cannot ſee your firſt Station-mark from your Third Station or Place of ſtanding, then according to the laſt Rule of Di-

rection, direct your Sights to some Angle in the Field which you have taken upon your Plot, and if the edge of your Index cut the same Angle upon your Paper, your Work is right, otherwise not.

IV. Likewise when your Table is rightly planted at your fourth Station, and all the Angles betwixt your third and fourth Station being taken, cast your Eye into that part of the Field you have Plotted, and view which of your Station-marks you can see that you are already come from, *viz.* either first or second; as suppose you could see only your second Station-mark, then direct your Sights from your fourth Station, or Place of standing, to your Second Station; and if the edge of the Index cut the second Station upon your Plot, your work is so far perform'd right, otherwise not; and if at any time you cannot see some one or more of your Beacons, or Station-marks, besides the last you came from, that you have already passed, then make use of some Angle, to prove your Plot by, as I said before; and by observing this Method, 'tis easie to know whether you have committed any Errour or not, and if you have, how and where speedily to find it before you be gone far past it; which is so plain and easie that it needs no farther Demonstration.

CHAP. XXXV.

Of proving the Field-Work taken by the Circles on the Table, representing the Theodolite, Peractor, Circumferenter, *&c.*

ACcording to the Way or Method of Plotting, delivered in the Thirtieth Chapter, by finding the quantity of every Angle by going round about a Field, there is one general Rule to prove the Field-Work by, if the Work be performed according to the Theodolite, *viz.* from the Circle of 360 Degrees, which most Authors make use of; which take as followeth: And,

First, Note that the quantity of Degrees each Angle contains are to be reckoned in the inside of the Plot, or their Complements to 360 without, *viz.* Of all those Angles that bend inward.

Therefore Multiply 180 Degrees, by a Number less by two than the Number of Angles in your Plot; the Product (if your Work be true) will be equal to the Sum of all the Angles observed added together.

But to prove the Field-Work according to the Natural performance of this Emperial Table, according to the several Circles there-

thereupon, and as the 24 Chapter directs, I need but only observe the proportion one Circle bears to another, as for Example.

In the Field-Book of the 24 Chapter, *page* 120, I add all the Angles of the Stationary distances together, taken by the Circle of 360 Degrees, which make 605 degrees, 45 Minutes; Then I add all the Stationary Angles taken from the Circle of 120 Degrees, which make 201 Degrees, 55 Minutes; Now the proportion betwixt these two Circles is as 3 to 1, so that adding 3 times 201 Degrees, 55 Minutes, makes 605 Degrees, 45 Minutes, agreeing with the Circle of 360 Degrees, which shews the Stationary Angles to be truly taken; then the Circle of four 90s, will either be the same with the Circle of 360 Degrees or its Complement thereto, as the bare Sight of the Field-Book will further inform you: So likewise may you prove the Field-Work of every Station as you puoceed with your Work, which is very easie and of excellent use.

CHHP. XXXVI.

How to take the Plot of a Field only by help of the Chain, otherways than is taught in the fourth Book.

AT some time or other it may so happen that you may be required to take the Plot of a Field when you are destitute of all other Instruments but your Chain, Pocket-Rular, and Compasses; in such a Case observe these following Directions.

Admit this following Figure, Noted with the letters A, B, C, D, E, F, represents a Field, of which the Plot is required.

First, then measure the length of the Hedge or Fence AB, whose length is found 53 Poles, 13 Links; then measure the length of the Fence B C, which is 43 *p*, 05 *l*; as also from A to C (which is the Base-line proper to that Angle) which is found 67 *p*. 04 *l*; all which write down in your Field-Book, as here it is denominated in the first Triangle A B C.

II. Then measure the second Triangle in the same order, beginning at C, and measuring to D, which length is found 19 *p*. 02 *l*; then measure from D to E, which is 38 *p*. 00 *l*. and likewise the Base-line C E, to that Angle, 54 *p*. 10 *l*. all which put down for the second Triangle.

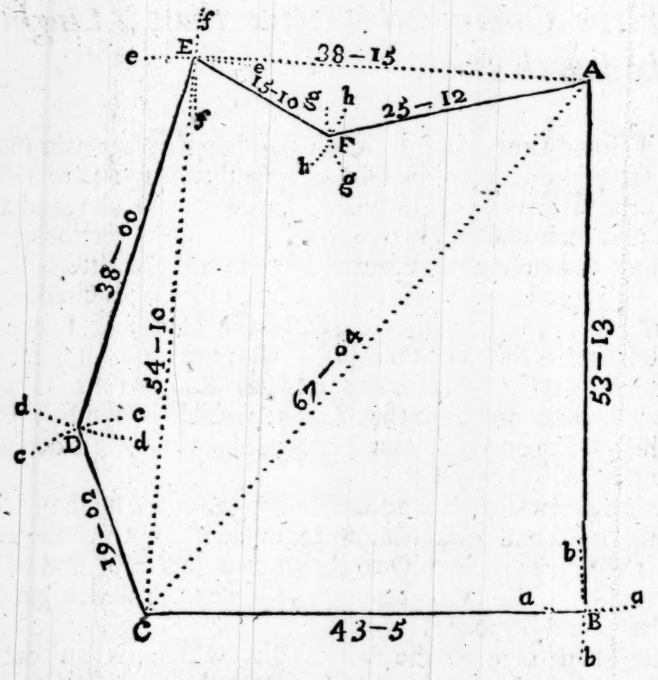
III. Then observe the last Angle which is an outward Angle, and must accordingly be measured on the outside of the Field, and likewise so Noted down in your Field-Book; so the length of the line E F, is 15 *p*. 10 *l*. and A F, 25 *p*. 12 *l*. and the

the Base-line to that Triangle A E, 38 *p.* 15 *l.* all which insert into your Field Book as follows.

	P.	*L.*
First Triangle A B C inward.		
A B	53	13
B C	43	50
A C	67	04
Second Triangle C E D inward.		
C D	19	02
D E	38	00
C E	54	10
Third Triangle A E F outward.		
E F	15	10
F A	25	12
A E	38	15

Directions how to Protract the Former Work upon Paper.

First then draw a line upon your Paper at Pleasure as A C, and take from your Scale the length of that line, 67 *p.* 04 *l.* and set it



from A to C; then take from your Scale the length of the line A B, 53 *p.* 13 *l.* placing one foot in A, and with the other make the part of an Arch *a a*; then take the length of the line B C, into

into your Compasses from your Scale, placing one Foot in C, and with the other foot cross the former Arch at B, as *b b*, then draw the two lines A B and B C.

II. Take from your Scale 54 *p* 10 *l.* the length of the Base-line CE, and placing one foot of the Compasses in C, with the other make the portion of the Arch *e e*, then take with your Compasses the length of the other Base line E A outward 38 *p.* 15 *l.* setting one foot in the point A, and with the other cross the former Arch at E, as *f f*, which point E is the extream Point or meeting Angle to both the other two Angles.

III. For the protraction of the Triangle C E D, take with your Compasses from your Scale the line C D, 19 *p.* 02 *l.* with which distance, place one foot of your Compasses in C, and with the other make the Arch *c c*, then with your Compasses take the length of the line D E, 38 *p.* 00 *l.* placing one of the Compass points in E, and with the other cross the former Arch at D, as *d d*, from which intersection and from the points C and E draw the two lines, *viz.* C D and DE.

Lastly from the Triangle A E F, take first into your Compasses 15 *p.* 10 *l.* the length of the line E F, placing one foot in E, and with the other strike the Arch *h h*, then take likewise A F, 25 *p.* 12 *l.* setting one foot in A, and with the other cross the former Arch at F, as *g g*, and where these two Arches intersect one another as at F, draw lines therefrom as from A to F, and from F to E, so is your whole Plot protracted upon Paper as was required.

And here Note, you must be careful to note down, as you measure the said Field, the Situation of the Angles, *viz.* inward and outward, for fear of committing a mistake when you come to protract the same.

CHAP. XXXVII.

How to take the Plot of a Lordship in Gross, or of any Champain Field, without shifting the Paper, upon the Plain-Table, *which may contain* 2000, 3000, *or* 4000 *Acres.*

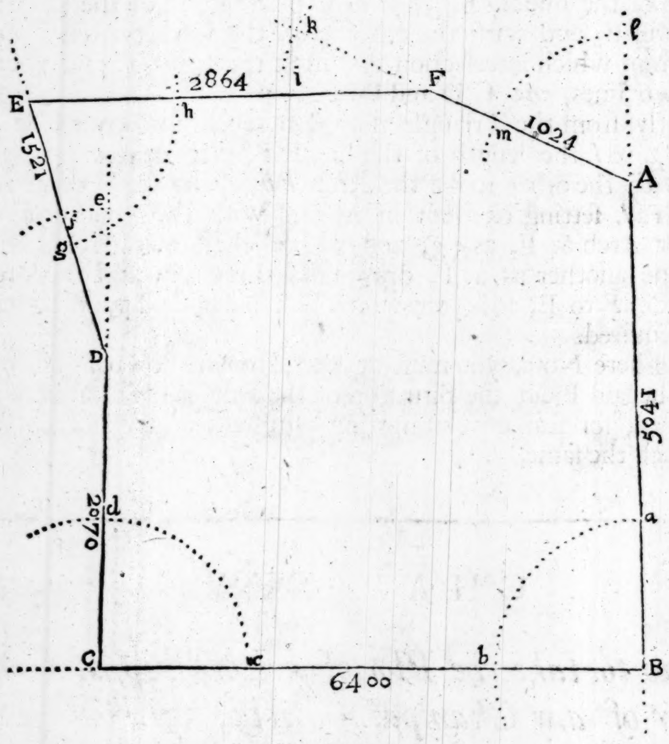
THIS way I am here about to illustrate is both easy, exact, and useful, for by placing your Table at every Angle, you are to take each Angle and his sides, without laying down from your Scale the true length of each Ground-line, as in the former Chapters, only measure the true length of each Hedge or Ground line, drawing it in its due order and Situation upon your Table, and write down its true length (not regarding the not closeing

of

of your Plot at Laſt) and in this order proceed from one Angle to another, ſtill keeping the limits of your Plot upon your Table, which is to be Protracted upon Paper according to its due proportion, when you come home.

EXAMPLE.

Suppoſe this following Figure Noted with the Letters ABCDEF, to be the Circumference of a Lordſhip, or ſome large Champain Ground, Firſt place your Table at A, and direct your Sights to B, and draw a line by the edge of your Index, repreſenting the line AB, then direct your Sights to F, and draw the line A F to any convenient length, then meaſure the length of the line A F 1024 Perches, and write it down upon the ſaid line, then take up your Table and as you go on to B mea-



ſure the line A B which is 5041 Poles, which write down upon the ſaid line: Which done, plant your Table at B, according to the Rules delivered in the twenty third Chapter hereof: Then making choice in ſome convenient place of the line A B, as at B, for your Second Station, from thence direct your Sights to C, and by the edge of your Index draw a line at a convenient length, then meaſure the ſaid line 6400 Perches which write down upon the ſaid line, then in ſome convenient place of the line B C, as at C, plant your Table, and direct your Sights to D, drawing a line at length by the edge of your Index; then with your Chain, meaſure its length

length, *viz.* from C to D, 2070 Poles which write down upon the said line.

In the same manner plant your Table at D, and direct your Sights to E, drawing a line at length by the edge of your Index; then measure the length of the Ground-line D E 1521 Poles, which also write down upon the said line.

Lastly in some convenient place of the line D E, as at E, plant your Table, and direct your Sights to F, and draw a line by the edge of your Index as before, then measure with your Chain the length of the Ground-line E F, whose length is found 2864 Poles, which also write down upon the said line, so is your Field-work finished, because you have the length of each Ground-line, and the true quantity of each Angle.

Note. And here Note that it is not to be supposed that the Plot taken upon the Plain-Table will close or come together as here; for that is not to be expected, tho' I have so ordered and disposed this Figure in respect it should also shew (to save labour) the Way or Method of Protracting or laying down the exact Plot upon Paper, for tho' the Last and First lines will not meet nor come together, it matters not, in respect you have the length of each line written down, and the true quantity of each Angle taken upon the Table, which is sufficient to Protract the true plot thereof upon Paper by these short directions following.

How to protract upon Paper the former Work in its true Proportion and Quantity.

First then draw a line at length upon your fair sheet of Paper as A B, (which to avoid prolixity we shall referr to the former Figure, Supposing it in proportion to the greater Magnitude to be truly taken) then from the Scale you would have your Plot protracted from, take in your Compasses the length of the line A B, 5041 Perches, which place from A to B, then opening your Compasses to a convenient distance, strike the Arch-line (both upon that Map you took upon the Table, and here) ***a b***, then take the quantity of that Angle as it was laid down upon your Plain-Table, and set it from ***a***, to ***b***, then draw the line B ***b***, at length, and (as before) take from your Scale the length of the line B C, 6400 Perches, which extent set from B to C, then lay down the quantity of the Angle at C, as you did that of B, as ***a b***, and in this order may you proceed from one Angle to another till you have gotten the exact Map upon your Paper, as the aforegoing Figure better then many Words may better inform you.

CHAP. XXXVIII.

Short Notes or Directions for taking the Map of a County.

THis is a Work which very few Authors of Surveying have touched upon, and indeed for me to demonſtrate it in all reſpects, will take up more time and room than I can ſpare; therefore I ſhall now treat of it with as much brevity as conveniently I may.

I. One common way that has been delivered by ſome Authors is by taking the Latitude and Longitude of the moſt Notable and Material Towns in the ſaid County, eſpecially all the Market-Towns, by which their diſtance has been laid down upon the Map; but this is very faulty: Firſt, By reaſon the Latitude is erroneouſly ſtated in ſeveral great Towns, and not known to all: Secondly, The Longitude of places was never yet ſo well agreed upon, as to be either credited or truſted to by our late Geographers in ſuch a caſe as this: And Thirdly, our Engliſh Miles are not near rightly adjuſted to the Degrees in the Heavens; for which reaſons I ſhall forbear explaining this way further.

II. The taking the Plot of a County may moſt exactly be performed by uſing this Inſtrument as a Theodolite, whoſe uſe is ſufficiently taught in the former Chapters; and here note by the way, that the diſtances of Market-Towns, and the length of all other Lines you have occaſion to meaſure, is beſt meaſured by the Wheel, which needs no deſcription, ſince the making of it is ſo well known to our Mathematical Inſtrument-makers; which by driving before you, tells the diſtance in Miles, Furlongs, &c.

III. In the beginning of your Work obſerve to begin at ſome Great Market-Town, noting down its Church and what is material to be taken; and from thence proceed to meaſure the next Great Town, taking all the other intermediate Towns, and alſo all Parks, Rivers, Foreſts, Interſecting-Roads, &c. in your way, which you are carefully to note down into your Field-Book, which Protract upon Paper every Night; you may alſo deſcribe the quality of the Country as you go, *viz.* Whether Hilly, Woods, or the like; and whatever is remarkable in your way; and to this way of Working, ſome of the exacteſt County-Maps may be very uſeful; and in this order proceed from one Town to another till the whole County-Map be finiſhed.

VI. But that way I moſt affect, (and am well aſſur'd is beſt and moſt exacteſt of all others) is by taking the particular Map of each Lordſhip, which may be performed by this Inſtrument uſed as a Plain-Table, or more properly as a Theodolite; whoſe

uſes

uses to this purpose may be consulted in the Twenty Fourth, Twenty Fifth, and Twenty Sixth Chapters of this Part; and so by joining each Lordship to another, as you was directed to joyn each Ground to another in the Twenty Seventh Chapter, which Chapter duly considered, may be looked upon as an Epitomie of this whole Matter; for the Work is indifferently the same; for whereas that Chapter plainly Demonstrates the taking of the exact Map of a Lordship, laying down the particular Grounds one by another; so in this 'tis but laying each Lordship down by another as you find they be in the County, which may be laid down by as small a Scale as you please, by which you may proportion your Map to what Magnitude you think most convenient

V. These brief Rules being well understood, and the Surveyor well grounded in the practical Part of the former Chapters, he will be sufficiently furnished for the taking of a County-Map; which is all I shall here say concerning this matter.

John Wing.

The End of the Fourth Book.

THE
ART
OF
SURVEYING,
BOOK V.

Wherein is ſhew'd *Arithmetically*, how to meaſure exactly all kinds of *Superficies* and *Solids*;

AS

Walls,	*Glaſs,*	*Roofs,*
Wainſcot,	*Board,*	*Painting,*
Tyling,	*Pavement,*	*Timber,*
Slating,	*Brickwork,*	*Stone,* &c.

With a Detection of ſome Common Errors us'd by ſeveral in the Performance thereof.

Formerly Publiſhed by
Mr *VINCENT WING*,
Now much Augmented and Publiſhed by his NEPHEW,
JOHN WING,
FOR THE
Benefit of *Surveyors* and *Builders*.

LONDON,
Printed for *Awnſham* and *John Churchill*, at the *Black Swan* in *Pater-Noſter-Row*, MDCXCIX.

THE ART OF SURVEYING.

BOOK V.

CHAP. I.

The Way of Measuring Masons Work, as Walls, &c.

FOrasmuch as the difference between the measuring of Land and these is only this, that Land is measured by the Pole or Perch, but these, some by one kind of measure, and some by another; as Walls, Slating, Tyling, and such like, by the Rod of 18 Foot Square: Roofing, Partitions, &c. by the Square of 10 Foot: Pavement and Wainscot by the Yard or Foot: and Board and Glass by the Foot only.

Therefore in measuring any of these things, consideration must be first had to the just Form and Figure thereof; and then according to the Rules delivered in the Second part of the Second Book, you may find the Area, or superficial Content. And forasmuch as it is very requisite and necessary for a Surveyor to know how to measure all manner of Buildings, as Walls, Timber-work, Tyling, Floors, Joyners and Painters Work, and such like, I shall in the following Chapters make illustration thereof.

EXAMPLE.

Suppose there be a Wall that is 54 Feet in length, and 21 Feet in height, and it is required to know how many Rods, Yards and Feet are contained therein. First, I Multiply 54 by 21, and the Product is 1134 feet, which I Divide by 324, (because there are so many Feet in one Rod) and the Quotient is 3 Rods, and 162 Feet remaining; which I Divide by 9 (for so many Feet are contained in one yard) and the Quotient is 18 Yards, and nothing remaining; so that when the Wall is 54 Feet long, and 21 Feet high, there are contained therein 3 Rods, 18 Yards 0 Foot, which is exactly 3 Rods and a half: For 36 Yards, or 324 Feet, make a Rod; 18 Yards, or 162 Feet, half a Rod; and 9 Yards, or 81 Feet a quarter of a Rod; the whole Work stands in the Margent.

54	
21	
54	
108	
1134	Product.
324	Divisor
972	(3 Rods.
162	
9	
	(18 Yards.
72	
9	
72	
0	

But suppose another Wall be to be measured, whose length is 75 Foot 10 Inches, and its height 15 Foot 5 Inches, the Content will be found 1169 Feet and $\frac{1}{12}$ of a Foot. But this way of Operation, I must here explain, since my Uncle hath not touched upon it in any of his Examples; and because it is the most facile way in casting up the Contents of those Dimensions that are given in Feet and Inches.

EXAMPLE.

First then, Set down your Numbers as in the Margent, *viz.* 75 Feet, 10 Inches, the length of the Wall, and under them 15 Feet 5 Inches the height; then Multiply the Feet together, *viz.* 75 by 15, and place their respective Products orderly under them, *viz.* 375 and 75, then Multiply crossways, that is, 75 Feet, by 5 Inches, and the Product is 375; now because Feet and Inches are Multiplyed together, the Product is long Inches, that is one of these long Inches is 12 Superficial Inches; therefore Dividing 375 by 12 (the number of long Inches in one Foot) and the Quotient is 31 Feet, and three long Inches, or $\frac{1}{12}$ of a Foot, which place down as you see in the Margent; then likewise Multiply 15 by 10, whose Product is 50 which Divide by 12, as before, and it gives 12 Feet, 6 Inches, which place down also as in the Margent, *viz.* Feet under Feet, and

F.	I.
75	10
15	5
375	0
75	0
31	3
12	6
0	4 $\frac{2}{12}$
1169	1 $\frac{2}{12}$

and Inches under Inches ; then Multiply the Inches together 10 by 5, which makes 50 Inches, which must be reduced to long Inches by Dividing the 50 superficial Inches by 12, which gives 4 long Inches and $\frac{2}{12}$ of an Inch ; your Figures thus placed, draw a Line under them, and add them together as in the Margent, so does the whole Content of the Wall appear to be 1169 Foot $\frac{1}{12}$ of a Foot, which divided by 324, as in the first Example, gives 3 Rods and 197 remaining, which Divided by 9, gives in the Quotient 21 Yards, and 8 Foot remaining ; hence it appears the Wall that is 75 Foot 10 Inches long, and 15 Foot 5 Inches high, amounts to 3 Rods, 21 Yards, 8 Foot, omitting the Fraction.

Note, Having thus largely explained this way of Cross-Multiplying, by casting up the Content in Feet and Inches in this Example; I shall not need to explain it further in what follows.

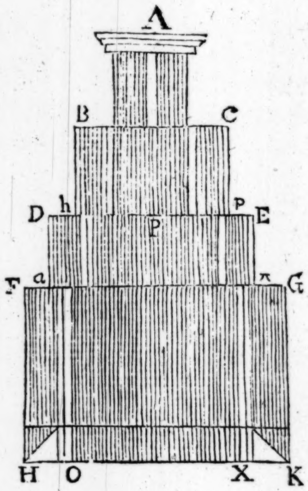
Gavels or Dormant Pikes.

But in measuring Gavels or Dormant Pikes, and the like, which are Triangular; you are to measure them as Triangular, as is taught in the Second Book ; as for Example, Suppose a Gavel or Dormant Pike, whose Base is 18 Foot, and the Height or Perpendicular 15 Foot: Here (according to the Ninth Problem of the Second Part of the Second Book) I Multiply the Perpendicular 15 by the Semi Base 9, and the Product 135 is the Content in Feet, which reduced into Yards, by Dividing it by 9, makes exact 15 Yards for the true content of the Gavel or Dormant Pike.

Measuring of Chimneys.

But in the measuring of Chimneys, which requires more accurateness of Workmanship than other ordinary Walls, they are usually accounted as double measure. But first to measure them as single measure, take the length of the Brest-Wall, and the two Sides or Angles, which Multiply in the height, and that Product being doubled yeildeth the Content, according to double measure which is customarily allowed ; yet some Workmen are so Covetous and Unconscionable, that they are not content to have double measure for the Brest-wall, and the two Angles, but would have the back of the Chimney double measure also whereas (for the most part) the Chimney is made against a Gavel, which is measured by it self; and so they would have that three times measured, which is and ought to be accounted but as Single measure, except the Gavel, which is usually allowed Square-measure.

Suppose this Figure A B C D E F G H K, be a Chimney that hath a double Funnel towards the top, and a double Shaft, and is to be measured according to double measure.



First, I begin at the Base, and take the length of the Brest-wall O X, and the two Angles K X, and O H, which together are 23 Foot; then I take the height of the Square H F, 17 Foot, 3 Inches, which Multiplyed together produce 396 Foot, 9 Inches, for the Content of the Figure, F G H K.

II. For the Square D *a* E *π*, the length of the Brest-wall and the two Angles D P E, is 14 Foot, and the height D *a*, 5 Foot, 3 Inches, which Multiplyed together makes 73 Foot, 6 Inches or half a Foot, for the Content of the Figure D *a* E *π*.

III. I take the length of the next Square B C *h p* which is 9 Foot, 3 Inches, being the length of the Brest-wall and two Angles, which Multiplyed by the height B *h*, 8 Foot 3 Inches, produceth 76 Feet, 4 Inches almost, for the Content of the Square B C *h p*.

IV. The Compass of the Chimney-shafts is 12 Foot, 2 Inches, and the height 6 Foot, which Multiply'd together, make 73 Foot for the Content of the Shafts.

V. The depth of the middle Fetter that parts the Funnels toward the top is 10 Foot, and its wideness 1 Foot, 3 Inches, which Multiplyed together makes 12 Foot, 6 Inches.

Note. And here observe, in the measuring of a stack of Chimneys that stands length-ways, that is, one by the side of another, the same Method is to be observed, with this Addition, that all the middle Fetters or Partitions between Chimney and and Chimney, is to be measured also; observe the same if a stack of Chimneys stand Square, and then you cannot easily err.

Lastly, Adding these five Summs together, and doubling the Aggregate, it produceth the Content of the whole Chimney, according to double or customary measure, as you see in this Paradigm.

		F.	*I.*
The Squares.	F G K H	396	9
	D *a* E *π*	73	6
	B C *h p*	76	4
The Shafts	A	73	0
The middle Fetter		12	6
	Aggregate	632	1
	The Double of it is	1264	2

The

the Content of the Chimney acording to customary measure, which reduced into Rods, as shewed before, maketh three Rods, 32 Yards, 4 Foot, and $1\frac{2}{3}$ of a Foot.

This is all the measure that can be allowed when the Chimney stands in a Gavel, or Side-wall: in which case, the Back of the Chimney (here not measured) is accounted as part of the Gavel, but if the Chimney or Chimneys stand by themselves, as all Stacks of Chimneys in great Buildings do, which in such a case is all Chimney work, and therefore ought to be measured double on all sides.

CHAP. II.

The measuring of Carpenters Work.

IN the measuring of Carpenters Work, we are to account it by the Square of 10 Foot every way, so that 100 Square Foot is one Square, where

Note, that $\left\{\begin{array}{l}\text{25 Foot is 1 Quarter}\\ \text{50 Foot is 2 Quarters}\\ \text{75 Foot is 3 Quarters}\end{array}\right\}$ of a Square.

And here we may observe that Carpenters Work that is to be accounted for by the Square, consists chiefly of three parts, *viz.* Flooring, Partitioning, and Roofing, in which we shall give an Example in each particular as followeth.

1. *Of Flooring.*

Suppose there be a Floor laid with Boards, whose length is 18 Foot, 6 Inches, and its breadth 18 Foot, 3 Inches; now these two Summs Multiplyed together, produce 556 Foot and an half, which is 5 Squares, and 2 Quarters or half a Square, and 6 Foot and an half.

Note. And here Note, That though 100 be the Divisor to Divide the number of Feet by, yet here is no occasion of making use at all of Division, but always to cut off from the Product 2 Figures toward the Right hand, so those Figures that remain on the Left hand shall be Squares, and the 2 Figures cut off to the Right hand parts of a Square.

2. *Of Partitions.*

Suppose a Partition between one Room and another should contain in length 20 Foot, 2 Inches, and in height 12 Foot, 5 Inches:

ches; hence to find the number of Squares, Multiply 20 Foot, 2 Inches, by 12 Foot, 5 Inches, and you will have in the Product, 250 Foot, 5 Inches, that is two Squares and 2 Quarters or half a Square, and 5 Inches, which Inches are needless to be accounted for in such cases as these.

3. *Of Roofing.*

First take the length of the Roof on one side and double it, which gives the length of both sides; and likewise take the depth of the said Roof, which Multiply by the length on both sides, or the Girth of the said Roof if it be Cullesed, and the Product will be the Content.

EXAMPLE.

Suppose the Girth (or length of both sides) of a Roof to be 120 Foot long, and the depth 18 Foot, 6 Inches; which Multiplyed together produces 2220 Foot, that is, 22 Squares, and 20 Foot, which wants 5 Foot of a Quarter of a Square more.

Other Measures.

Lastly, There are other things belonging to Carpenters Work, and are to be measured several ways, as Lintails and Discharges, with Cornishes, Rails, and Ballisters, *&c.* all which are measured by the Foot, running measure.

CHAP. III.

The measuring of Joiners Work, And Painters.

IN measuring of Joiners and Painters Work, observe these following Directions.

I. Joiners and Painters Work is computed by the Yard, or 3 Foot each way, which makes 9 Superficial Foot, which is accounted one Yard.

II. In taking the Dimensions in the height of the Room (which is to be taken with a Line) you are to Girth over every member of the Cornish, and other members of the Wainscot, which where the moldings swell much, considerably augment the height of the Room.

III. The Girth of the Room is only to be taken in its true length and breadth, without putting the Line into the Moldings

as

as you did in the height; but some Painters have a custom (though for what reason I know not) to draw the Line over every member of the Wainscot in the Girth of the Room as well as the height.

IV. There is one thing in Joiners Work very observable, and that is, by measuring Doors and Window-Shutters, which are wrought on both sides; for which they are always paid for work and half, and that they have just reason to claim, for the Work is double though the Stuff is Single.

V. All Window-Jaums, and Saphetaes are to be measured by themselves, and the Window-Lights and Chimneys (if any be in the Room) are to be deducted out of the whole at last.

VI. The Painters are not to account for work and half, but to account (in some cases) the Room once, twice, or three times done over, or so much *per* yard, considering the goodness of the Work.

The Dimensions being taken according to the preceding Directions, we will endeavour to explain the whole by one Example of a Room whose

Girth or Compass is 256 Foot 6 Inches,
And its height 15 Foot 9 Inches.

I. Multiply 256 Foot 6 Inches by 15 Foot 9 Inches, the Product is 4039 Foot 10 Inches, which divided by 9, gives in the quotient 448 Yards, 7 Foot, 10 Inches.

II. Let us suppose all the Window-Jaums, and Saphataes to be 56 Foot, 4 Inches, and their breadth 2 Foot, 2 Inches; which Multiplyed, produces 122 Foot, which Divide by 9, the quotient is 13 Yards, 5 Foot.

III. All the Window-Shutters about the Room is in Girth or Breadth 28 Feet, 3 Inches, and the length or height of them 5 Foot, 7 Inches, which Multiplyed and Divided as before, makes 17 Yards, 4 Foot, 8 Inches; and its half is 8 Yards, 6 Foot, 10 Inches, which added to 17 Yards, 4 Foot, 8 Inches, makes 26 Yards, 2 Foot, 6 Inches, for the true Content of the Window-Shutters for Work and half work.

IV. These several Sums added together as follows, give the Content of the whole Room, 488 Yards, 6 Foot, 4 Inches, from which take 19 Yards, 4 Foot, 6 Inches, being all the Deductions in the said Room, *viz.* Chimney and Window-Lights; hence the Exact Content appears to be 469 Yards, 1 Foot, 10 Inches; and this is the true way of measuring, and so much the the Workman ought to be paid for.

The

The Summs added together.

	Y.	F.	I.	
The several parts	448	7	10	cast up
	13	5	00	
	26	2	06	
The whole	488	6	04	
Deductions	19	4	06	
The true Content	469	1	10	

CHAP. IV.

Of the measuring of Brick-Work and Tyling.

FIrst, I shall join the Bricklayers and Tylers Work together, in respect they are commonly performed by the same hands, though the way of accounting for is different, for Tyling is commonly reckoned for by the Square of 10 Foot, as Carpenters work is, only they demand allowance of double measure for the Eves, and Running measure for the Hips and Gutters but this depends upon the custom of the place; however some allowance in these cases ought to be had, in respect of measure or price.

II. Brick-walls are measured in some places by the Rod of 16 Foot and half each way, so that one of these Rods do contain $272\frac{1}{2}$ Square Foot; which is proved by Multiplying 16 Foot, 6 Inches into it self, and this is called Statute-measure, though it is used in very few places in the Country that I know of.

III. There is another sort of Rod of 18 Foot Square, which makes 324 Square Foot in a Rod; and this is a measure sometimes used in the Country, being the same Rod the Masons here make use of.

IV. But the Rod most in use here in the Country, contains only 54 Square Foot upon the Superficies, or 6 Square Yards, being one sixth part of the Rod last named of 18 Foot Square.

V. Hence the Surveyor is to examine (before he begsns to measure) what Rod it is the Master and Workmen did agree upon, that he may do them both Justice.

VI. Because Brick-Walls are not always made of one thickness, they are to be reduced to the Standard-measure, *viz.* of a Brick and half thick; all which shall be further explained by the Examples following.

EXAM-

EXAMPLE.

Suppose a Brick-wall be 167 Foot long, and 16 Foot high, now by Multiplying these two numbers together, gives in the Product 2672 Foot, which to reduce into Rods according to any of the Rods before mentioned and explained; Divide the said 2672 Foot, by $272\frac{1}{2}$ for Statute-measure, or by 324 the Square of 18 Foot, or by 54, the Divisor of the lesser Rod; according to any of these ways you may see by this following Paradigm, what the number of Rods is.

			R.	*Y.*	*F.*
If Divided by	$272\frac{1}{2}$	there is contain'd in the Wall	9	24	$3\frac{1}{2}$
	324		8	8	8
	54		49	2	8

Now when you have Divided by any of these Divisors, and that the Remainder exceeds 9 (as it did in all these Examples) you are to divide the said Remainder by 9 (it being the number of Feet in one Yard) so have you the content in Rods, Yards, and Feet as before; and this I think is sufficient to explain the whole matter.

Note. The next thing considerable is, that all Brick-walls of the same height and length do not contain the same number of Rods, in respect of the thickness of the Wall; for the thicker the Wall, the more Rods are contained therein, *viz.* If a Brick-wall be thicker than one Brick and half thick, then a Square Rod upon that Wall, will be more than a Rod; hence every Rod upon the Superficies of a Wall that is 3 Bricks thick, will contain 2 Rod; and a Rod upon a Wall of 4 Bricks thick, and half, will be 3 Rods; I shall therefore in the next place set down one General Rule to Reduce a Brick-wall of any thickness to the thickness of a Brick and half, the Standard-measure,

A General Rule for Reducing of Brick-walls to Standard-measure.

A General Rule.

Multiply the Number of Superficial feet which is contained in the Superficies of any Brick-wall, by the number of half Bricks the said Wall is in thickness; one third part of that Product is the Content of the said Brick-wall in Feet, reduced to a Brick and half.

Hence if a Wall of 5 Bricks thick should contain 2672 Feet, upon the flat or superficies; if you Multiply this number by 10 (the number of half Bricks the Wall is in thickness) the Product pro-

produces 26720, one third part whereof is 8906⅔ Foot, which is the exact number of Feet contained in that Wall, as it is reduced to a Brick and half thick, which how to bring to Rods, &c. I have just before shewed.

Of Tyling.

Suppose a Roof in length 120 Foot on both sides, and the depth of one side (with the customary allowance at Eves) 18 Foot; these two numbers multiplyed together produce 2160 Foot, which is 21 Squares, and 60 Foot, that is, 10 Foot above half a a Square more, according to the Directions of the *2d.* Chapter.

CHAP. V.

The measuring of Plaisterers Work, and Slating.

FIrst, Slate-Work is generally accounted for by the Rod of 18 Foot Square, which contains 324 Superficial Feet as I intimated in the last Chapter.

II. Where a Roof is covered with Slate, there ought to be an allowance at the Eves equivalent to the Projecture of the Eves over the Wall below the Roof, which is generally termed double measure at the Eves, which adds to the depth of the Roof, 18 or 20 Inches, sometimes 2 Foot.

III. Where there is Gutters or Valleys, there ought to be an allowance also, which is to take the Girth, or length of the Roof with the Gutter or Valley, all along the Ridge-Tile, which makes the Gutters double measure, *viz*, as much more as really it is, which in some places is allowed, and in some places not, which chiefly depends upon the Custom of the Place.

IV. If the length of the Roof be taken, in Feet and Inches, and the depth on both sides, with the usual allowance at the Eves, and in the Gutters, and Multiply'd together, and the Product thence arising divided by 324, and the remainder again by 9 (if it exceed 9) you will have the Content in Rods, Yards, and Feet.

EXAMPLE.

Of a Roof covered with Slate, whose length is 52 Foot, 6 Inches, and the Depth of the said Roof on both sides (with the usual allowance of the Eves) 34 Foot; that is, 17 Foot for the depth

depth of one side: Now 52 Foot, 6 Inches, the length, being Multiplyed by 34 Foot, the depth on both sides, the Product is 1785 Foot, which divide by 324, the Quotient is 5 Roods, and 165 Foot remaining, which Remainder divide by 9, the Second Quotient is 18 yards, and the Remainder 3 Foot; so that you see that Roof that is 52 Foot, 6 Inches long, and 17 Foot deep, amounts to 5 *R.* 18 *Y.* 3 *F.* And because this sort of measuring is so plain, more Examples will be needless.

Of Plaisterers Work.

I. Plaisterers-Work is of 3 sorts, as first, The Running of Plaister-Floors; secondly, The Ceiling of Upper-Rooms with Reed, Nails, Lath, Lime, Sand, and Hair; and thirdly, The Pargin of bare Walls, with Lime, Sand, and Hair; before which there is generally laid first upon the Wall a Coat of Hay and Morter, otherways it would take up too great a quantity of Lime, Sand, and Hair.

II. All these several sorts of Plaisterers-work is generally accounted for by the Yard, or the Square of 3 Foot, which makes 9 foot in each yard; hence Examples are needless; for the Dimensions being taken in Feet, and Inches, and Multiplyed together, and the Product Divided by 9, you will have the number of Yards in the Quotient, and the Remainder will be the odd Feet.

CHAP. VI.

The measuring of Board and Glass.

I. IN the measuring of Glass and Board, the Content is usually given in Feet, and Inches, therefore they may the better be joined together.

II. The Dimensions are mostly taken in Feet and Inches, and the Length and Breadth so multiply'd together, produces the Content.

III. In the measuring of Board, if the Breadth in Inches be Multiplyed by the Length in feet, and the Product Divided by 12, the Quotient will give the Content in Feet, and what remains, is so many 12th parts of a Foot.

IV. Sometimes more Curiosity is required in measuring of Glass, and in taking the Dimensions Feet and Inches will not be near enough; therefore the Dimensions may better be taken in Inches and 10*th* parts of an Inch; which Multiplyed together, and the Product Divided by 144 (the number of inches in one Foot)

ſo will the Quotient produce the number of Feet, and the Remainder the odd Inches, or 144th parts of a Foot.

V. All theſe Caſes will be better explained by the Examples following.

I. *Of Glaſs.*

EXAMPLE.

Of a Window-Light of Glaſs whoſe height is 4 Foot, *6* Inches, and $\frac{3}{10}$ parts of an Inch, or 54 Inches and $\frac{3}{10}$ of an Inch; and the breadth 20 Inches, and $\frac{7}{10}$ parts of an Inch; which Multiplyed together as in the Margent, and the Product is 1124Inches, and $\frac{1}{100}$ parts of an Inch; which is not worth taking notice of, therefore we omit it; hence 1124 Divided by 144, the Quotient is 7 Foot, and the Remainder 11*6* Inches or $\frac{116}{144}$, which is 8 Inches above three quarters of a Foot more.

```
     54.3
     20.7
   -------
     3801
   10860
   -------
   1124.01   Product.
   144      (7 144/116 quo.
   1008
   -------
    116
```

Note. And this one Example I think ſufficient to explain the whole matter of Glaſs-meaſure; with this caution, *viz.* That where the Windows are either Round or Eliptical, that the Workman be allowed as Square-meaſure; that is, by taking the Diameters as the ſides of a Square; The reaſon of this allowance is, becauſe of the great waſte of Glaſs that is made in fitting it to the Arch of the Window.

II. *Of Board-meaſure.*

EXAMPLE.

Suppoſe a Board 11 Foot in length, and 10 Inches broad, now if 11 Foot be Multiplyed by 10 Inches the Product is 110, which Divide by 12 (becauſe the Multiplication was made in Feet and Inches) and the Quotient is *9* Foot and $\frac{2}{12}$ of a Foot: Where note, if *3* had remained it had been a quarter of a Foot if *6* half a Foot, and if *9* three quarters of a Foot.

But if the Board had not been an even number of Feet in length, then the Dimenſions may be taken in Inches, and 10th parts of an Inch; and the breadth alſo (if need require) which Multiplyed and Divided, as in the Example of Glaſs, will accordingly produce the Content.

CHAP.

CHAP. VII.

Of Stereometry, *or the mensuration of Solid Bodies, as Timber and Stone; and first of that which is Square.*

A Solid Body is that which hath both length, breadth, and thickneſs, as Timber, Stone, and ſuch like, which are commonly meaſured by the Foot. And herein you are to obſerve, that a Foot of Timber or Stone is accounted a Foot Square every way, in the form of a Die; whereby it appears, that a Foot of Timber is 12 times more than a Foot of Board; ſo that a Foot of Board being 144 Inches, a Foot of Timber muſt be 1728 Inches.

For Timber-ſticks that are Squared, you may find the Content thereof on this wiſe. Multiply the breadth by the thickneſs, and then Multiply the Product by the Inches of the length, ſo will you have the ſolid Content of the whole Piece of Timber in Inches; which being Divided by the Solid Inches in one Foot; namely 1728, the Quotient will ſhew how many Feet are in the Piece of Timber.

EXAMPLE.

Suppoſe a Piece of Timber be 9 Inches thick, 15 Inches broad, and 12 Foot or 144 inches long. Firſt, I Multiply 15 by 9, and the factus 135 is the Area of the Plain; which I again Multiply by the length 144, and the Product 19440 is the Content in Solid Inches, which being Divided by 1728 (the Square Inches in one Foot) the Quotient will be 11 $\frac{432}{1728}$, or 11.25, ſo that when a Piece of Timber is 9 Inches in thickneſs, 15 Inches in breadth, and 12 Foot in length, there is contained in it 11 Foot and a quarter of a Foot, according to the true and ſubſtantial Grounds of Art.

Performed another way.

To perform the former Work an eaſier way, the breadth and depth, 15 and 9 Multiplyed as before, produces 135; which Multiplyed by 12, the length in Feet, the Product is 1620, which Divided by 144, the Quotient is 11 $\frac{36}{144}$, or 11 Foot and a quarter, as before.

But yet I know it is a very common thing amongſt Carpenters to add the broader and narrower ſides together, and to take the half for the true Square, which way (though it be much uſed) is very erroneous, eſpecially when the difference between the ſides is much, as in the former Example; where the one

ſide is 15, the other 9, and the Summ 24; therefore they reckon 12 for the true Square; and ſo conclude there are 12 Square-Foot of Timber in that Piece, whereas there are exactly but 11 Foot and a quarter, as before is proved.

To find the true Square of a Piece of Timber when the one Side is broader than the other; Multiply the ſides together, and the Square Root of that Product yieldeth your deſire.

As in the former Example, I Multiply the one ſide 15 Inches, by the other 9, and the Product (as before) is 135, whoſe Square-Root is near upon 11. 62; which is the true Square thereof.

CHAP. VIII.

To meaſure Round Timber.

TO meaſure Round Timber, you muſt firſt find the Area of the Circle (whoſe Circumference is equal to the Compaſs of the Tree) as you are taught in the Twentieth Problem of the Second Part of the Book of *Geometry*. And this ſhall be made clear by an Example or two, ſuppoſing the Areas of both ends of the Timber-Stick to be equal.

EXAMPLE. I.

Suppoſe there be a Round Piece of Timber, whoſe Compaſs is 5 Foot and a half, or 66 Inches, the Diameter or greateſt Thickneſs thereof 21 Inches, and the length 12 Foot, or 144 Inches. Firſt, I Multiply the Semidiameter (or half the thickneſs of the the Timber-Stick) 10. 50 in half the Circumference 33; and the Product is 346.50; which again Multiplyed by the length 144 Inches and the reſult 49896.00, being Divided by 1728, the Quotient is 28.875; ſo that there is 28 Foot of Timber, and above three quarters of a Foot in the Stick, whoſe Circumference is 5 Foot and a half, and the length 12 Foot.

Otherways.

Or if 346.50, the Area of the Circle be Multiplyed by 12, the length in Foot, the Product will be 4158.00, which Divided by 144, the Quotient is $28\frac{126}{144}$, or 28 Foot, and ſomething above three quarters of a Foot, as before.

But by the way, I ſhall divulge one common Errour in meaſuring Round-Timber, crept in for want of Art, which having got poſſeſſion of the greater ſort of Artificers, is (by long continuance) grown almoſt irrecoverable, and that is in girdling of the Round Piece of Timber, or Tree, and of that Circumference to take a fourth part for the Square.

As

As in the former piece of Round Timber, the Circumference is 66, the $\frac{1}{4}$ whereof 16.50, they account the side of the Square, which Multiplyed in it self produceth 272.25 for the Area of the Basis; which if you Multiply by the length 144, the Product is 39204.00 the Content in Inches, which Divided by 1728, the Quotient is $22\frac{2}{3}$ Foot, which is apparently erroneous, differing from the truth no less than 6 whole Foot, and that too little as appears before, which for further Trial, we shall also examine by Mr. *Gunter*'s Rule in his Second Book of the Cross-Staff, Page 44. Prop. 9.

As 1000, to 2821, so are 66 Inches to 18.6186 the side of the Square, which Multiplyed in it self, produceth 346.65; now this being Multiplyed by the length 144, the Product is 49917.60, which being Divided by 1728 giveth 28 Foot, 88 Parts, agreeing nearly with our former way of mensuration.

But in such cases as these, Men commonly plead Custom, and will be ready to say, they make allowance for the Bark and wast in hewing, which indeed ought to be done in the Price, and not in false measuring; but in measuring a Round Column of Stone no such allowance can any way be laid claim to, because there is no wast.

CHAP. IX.

To measure Timber having 3, 5, 6, 7, or more Sides equally Squared.

IN Timber be neither Round nor four Square, but is either Triangular, or else consisteth of more than four Sides, you must still find the Area of the Plain, according as hath been taught in the Second part of the Book of *Geometry*, and then Work as in the former Chapters for the Content; but to explain it more fully, I shall add some Examples.

EXAMPLE.

Suppose a Piece of Timber consist of three equal Sides, each side being 18 Inches, the length of 6 Foot, or 72 Inches. First, I seek the Area of the Plain according to the 9th Problem of the the Second Part of the Book of *Geometry*, and find it 140.30, which I Multiply by the length 72 Inches, and the Product is 10101.60, which Divided by 1728, the Quotient is 5 Foot, 846, for the Content of the three equal-sided Piece of Timber.

But if a Piece of Timber consist of more sides than four, you must still find the Area of the Plain.

EXAM-

EXAMPLE.

Suppose a Piece of Timber have six equal sides, each side containing 10 Inches, the length 7 Foot, or 84 Inches. First, (according to the 18th Problem in the Second Part of the Book of *Geometry*) I take the Area of the Plain 259.80, which I Multiply by the length of the Stick 84, and the Product is 21823.20, which Divided by 1728, the Quotient is 12 Foot $\frac{2}{3}$, or Decimally 12.63.

The like you are to observe in all Pieces of Timber of Six, Seven, and Eight sides or more, and thus much briefly concerning Round and Square Timber.

CHAP. X.

The Dimension of Pyramids or Cones.

If a Piece of Timber be right-lined, having but one base, and end in a sharp point, it is called a Pyramid; but if the base thereof be round it is a Cone, according to the common Definition.

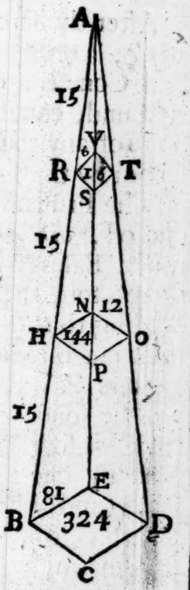
The Solid Content of either of these Figures is found by Multiplying the Superficial Content or Area of the Base, by a Third part of the length.

Suppose the Pyramid represented by the Figure A B C D be to be measured, whose side at the Base B C, or B E is 18 Inches, and the length A B 45 Foot, or 450 Inches. First, I Multiply the side of the Pyramid at the Base 18 in it self, and the Product 324 it the Area of the Base, which I again Multiply by a third part of the length, 180 Inches, and the Product will be 58320 the Solid Content in Inches in the whole Piece, which being Divided by 1728, the Quotient is 33 Foot, and 1296 Parts of a Foot, which is 33 Foot and 3 quarters.

The

The Operation in common Numbers.

18	side of the Pyramid	58320	
18		5184	
144		1728) 6480	($33\frac{1296}{1798}$
18		5184	
324	Area of the Base.	1296	Remain.
180	Third Part of the length.		
25920			
324			
58320	The Product.		



The little Pyramid, noted with the Letters ARSTV, is but 6 Inches square at the Base, whose Area is 36; which multiplied by a third part of the Length, 60 Inches, produceth 2160, that is, 1 foot, and 432 parts, or 1 foot and a quarter.

But suppose the Content of the Segment ONHBCD were required; the Squares at the Base are 144, and 324, which multiplied together, produceth 46656, whose Square-Root is 216, for the Geometrical-mean Square.

Otherways.

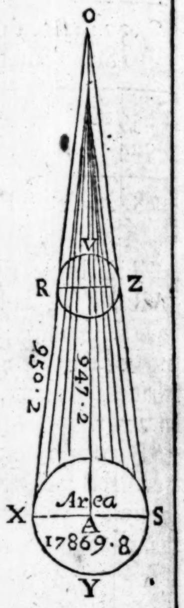
Or otherways, find the part cut off, which taken out of the Pyramid leaveth the solid Content of the Frustum. To find the whole length, use this Analogy; As the Difference of the Diameters length, to the length between them; so the Diameter of the greater Base, to the whole Length of the Pyramid: And consequently the part wanting comes to be known, which measured as a Pyramid (as indeed it is) whose solid Content being substracted out of the whole Pyramid, leaveth the Content of the Frustum, or tapering Timber-stick, which is the true Method of measuring squared tapering Timber, which shall be further exemplified in measuring of Cones.

Of

Of Cones.

After the ſame manner are Cones to be meaſured: As for *Example*;

A Cone is a Figure having length, and only one Baſe, which is round, equally decreaſing, and terminates in a point, as the Spire of any round Steeple, which is here repreſented by the Letters O X Y S.



The Fruſtum of a Cone, is part of the Cone cut off, *viz.* the bottom part, and hath two round Baſes, whoſe Baſe is always greater at the bottom than at the top, more or leſs, according to the Taper, and parts of the Timber-ſtick cut off, as it is here repreſented by the Letters Z V R X Y S.

The ſolid Content of a Cone (as in a Pyramid) is found, by multiplying the Area of the Baſe by one third part of the length; where note (and likewiſe in the Pyramid) the true length is from the Center of the Baſe, to the terminating point, as from O to A, and not the Hypothenuſe O X, or O S, tho' I have follow'd my Author in that reſpect in the Pyramid, yet ſhall ſomewhat digreſs from him here, and ſhew how the true length is to be obtained.

Firſt, Take the length of the Hypothenuſe or Slope-line O X, or O S, which we will here ſuppoſe 950.2 Inches, and the Semidiameter X A, or S A, 75.4 Inches; ſquare both theſe Numbers, that is multiplying them in themſelves; ſo will the Square of 950.2, be 902880, and the Square of 75.4, is 5685: Then ſubſtract the Square of the Semi-baſe, 5685, from 902880, the Square of the Hypothenuſe, and the Remainder is 897195, whoſe Square-Root is 947.2 Inches, the true Height required.

Then to find the ſolid Content of the Cone, multiply the Area of the Baſe, 17869.8 Inches, by 316 Inches, a third part of the Length, the Product is 5646856.8 ſolid Inches, which divided by 1728, the Quotient is 3267 Foot, and $\frac{1480}{1728}$ parts of a Foot, the Content of the whole Cone in ſolid Feet.

To meaſure round tapering Timber, which is the Fruſtum of a Cone, as is here repreſented by R X S Y; Firſt then, find the Area's of the Circles at both ends, and then proceed in all reſpects to find the ſolid Content, as in the Fruſtum of a Pyramid.

CHAP.

CHAP. XI.

The menſuration of a Globe or Sphere, and its Fruſtums.

A Sphere or Globe is a Solid every way Circular, made by the Motion of a Semicircle about its Diameter, being an exact round Solid, ſuch as are the Balls of Freeſtone-Peers and Gates before the Front of any Spacious Building.

To find the ſolid Content, there are ſeveral ways; As firſt, Multiply the Cube of the Diameter by 11, the Product thence ariſing divide by 21, the Quotient is the ſolid Content.

2. Or, Multiply the Area of the Circle, equal to the Diameter, by one ſixth part of the Globe's Superficies, the Product is the ſolid Content: Or one ſixth part of the Diameter multiplied by the Sphere's Superficies gives the ſame.

3. Otherways, Multiply the Area of the ſaid Circle by two thirds of the Diameter, the Product is the ſolid Content: Or, Multiply the Diameter by two thirds of the Circle's Area, performeth the ſame.

EXAMPLE I.

Of a Sphere whoſe Axe is 54.6 Inches, and the Circumference 171.5 Inches, the Convex Superficies (according to the *29th Prob.* of the *Second Part* of the Book of *Geometry*) is 9363.9, the Cube of the Axe is 162771, which multiplied by 11, gives in the Product 1790481; which divided by 21, gives in the Quotient 85261 ſolid Inches; which divided by 1728, gives 49 $\frac{589}{1728}$ Foot ſolid.

EXAMPLE II.

One ſixth part of 54.6 the Axe, is 9.1, by which multiply 9363.9, the Product is 85212, which divided by 1728, the Quotient is 49 $\frac{540}{1728}$ ſolid Feet, nearly agreeing with the former.

EXAMPLE III.

The Area of the Circle is 2341, which multiplied by 36.4, gives in the Quotient 85212, which divided as before, giveth 49 $\frac{540}{1738}$ ſolid Feet, exactly agreeing with the former.

Of the Frustums of a Sphere or Globe.

The Frustum of a Sphere or Globe, is a part cut off, whose Base is a Circular Plain, and whose solid Content may be found by having the Diameter of the whole Sphere, with the Diameter and Height of the whole Frustum; then use this Analogy; As the Remainder of the Axe, or Diameter, is to the Frustums Height; So is the Semidiameter of the whole Sphere, to the solid Content of the Frustum.

If two Frustums be cut off from a Sphere, so that the Plains of the Bases are Parallel, and that the Solidity at the middle part is required; it is but finding the Contents of both Frustums, which subducted out of the whole Globe, leaveth the Solidity of the Middle, or part left.

Thus far of measuring of *Buildings*. I shall, in the next place, conclude this Book with one useful Chapter, *viz.* of setting the Prices of Workmanship and Materials belonging to Buildings, which are the most material to be taken notice of, according to the custom of the Country, because I would not leave my Surveyor unfurnished in so useful a Part of his Profession, whereby the Master always may inform himself how to proceed in Bargaining both for Materials and Workmanship, before he proceed to raise his Intended Building.

CHAP. XII.

Containing the Rates and Prices of Workmanship and Materials belonging to Buildings, *and first of* Mason-Work.

FEnce-Walls and ordinary Buildings is each (only the Workmanship) from 16 Shillings to 3 *l.* 10 *s.* *per* Rod of 18 Foot Square which depends upon the goodness of the Work.

The setting of the Fronts of great Buildings, *viz.* Ashlar, Architrave, Windows, and Doors, with the Ground-Table, Fasha's, and other Members is Worth from 3 *l.* 10 *s.* to 5 *l.* *per* Rod, which depends upon the height and well performing of the Building: Chimneys raising in such Buildings are worth 3 *l.* a Rod, or 1 *l.* 10 *s.* double Measure.

Pavement laying is worth a half-penny a Foot.

Setting or Pitching with Rough Stone, is worth from 4 *d.* to 12 *d.* per Yard.

Of

Of Free-Masons or Quarrie Work.

Ashlar (at the Quarrie) is worth 3 *d.* or 4 *d. per* Foot.

Random-Pavement at the Quarrie is worth 2 *d.* halfpeny or 3 *d. per* Foot.

Diamond-Pavement, is worth 3 *d.* halfpeny, or 4 *d. per* Foot.

Rustick Quonys, at 2 Foot and 1 Foot each face, at the Quarrie, are 1 *s.* 4 *d. per* Quonie or 1 *s.* 3 *d.* a piece, or 5 *d. per* Foot, in some places 4 *d.* per Foot or 1 *s. per* Quonie.

Architrave Doors and Windows, are worth according to their Wideness or breadth of the Mouldings, a Penny an Inch, that is to say, if the Breadth of the Moulding (*viz.* from the out side to the inside of the Window-Frame) be 9 Inches, it is worth 9 *d. per* Foot, running measure, if 10 Inches, 10 *d. per* Foot, and so proporionably more or less.

Ground-Table is worth from 4 *d.* to 8 *d. per* Foot, running measure.

Frontish Doors in great Buildings, with their Ornaments, as Pillasters, &c. is worth (according to their Magnitude and varietie of Workmanship included) some 3 *l.* some 5 *l.* to 10, or 20 *l.* perhaps more.

Chimney-Shafts for ordinary Buildings with Architrave Frize and Cornish, is worth from 15 *s.* to 20 *s.* according to their height and Substance, without Architrave and Frize, from 10 *s.* to 20 *s.* But in great Buildings they are usually done by the Foot, *viz.* at about 6 *d. per* Foot.

Chimney-Pieces of Free-Stone wrought plain are worth 10 *s.* but there may be such Moulding wrought in them, which with their Coves and other Members may be worth 20 *s.* 30 *s.* or 40 *s.* a piece.

A Pair of Peers, with Seat-Arches, 4 or 5 Foot wide, and 14 or 16 Foot high is worth 40, or 50 Pounds.

Rustick Peers a Pair, are worth 10, 12, or 14 Pounds, according to their height and Substance; Plain Peers 8, or 10 Pounds, Revailed and Pillaster-Peers, from 10, to 14 Pounds a Pair.

Cornishes are worth according to their Nature and Bigness; a Moddillion-Cornish of about 18 or 20 Inches thick, is worth 5 or 6 shillings *per* Foot, running measure.

Of the Rates and Prices of Carpenters-Work.

Roofing and Flooring in ordinary Buildings is worth 7 *s.* or 8 *s. per* Square, but in great Buildings 10 *s.* or 11 *s. per* Square.

Ceiling-beams, Coveing and such like is worth 4 *s. per* Square.

Partitioning is worth 6 or 7 *s. per* Square.

Transom-Windows for great Buildings is worth making 1 *s.* 9 *d. per* Light, or 7 *s. per* Window.

Batten Doors worth making (for ordinary Door Cases, as about 6 or 7 Foot high, and 3 Foot wide) 4 Shillings.

Plain Doors, for such like Door-Cases are worth making 2 *s.* or 2 *s.* 6 *d. per* Door.

Rails and Ballisters on Balconies, or upon, or about the Pat form of great Houses, is worth (only Workmanship) 4 *s. per* Yard running Measure.

Lucan-Windows making and setting up, are worth 9, 10, 12, or 14 shillings *per* Window, which price is varied according to their Bigness.

Coveing Work, Sawing and putting up with the sliders, is worth 10 or 11 *s. per* Square.

Of the Rates and Prices of Joyners-Work.

Wainscotting with *Norway* Oak, the Workman finding the Stuff, is worth 7 *s.* per Yard, but if the Master find the Stuff, then is the working Part worth 3 *s.* 6 *d.* or 4 *s. per* Yard, and where the Moldings are very large it is worth 5 *s. per* Yard.

Plain-Square Wainscoting (the Workman finding Deal) is worth 3 *s.* or 3 *s.* 6 *d. per* Yard.

Ordinary Bisection-Wainscoting (the Workman finding Deal) is worth 4 *s.* 6 *d. per* Yard.

Large Bisection-Work is worth 6 or 7 *s. per* Yard of *Dantzick* Stuff, and Large Picture-Frame of the same Stuff is worth 10 *s. per* Yard.

Moddillion-Cornish with its Carved Work, is worth 7 *s. per* Foot.

A plain Moddillion-Cornish of 12 or 14 Inches, will be worth 3 *s.* 6 *d.* or 4 *s. per* Yard running Measure.

Deals dressing are worth 1 *s. per* Score, or 6 *s. per* Hundred.

Deal-Floors, ordinary (the Working part) are worth, Laying, 5 *s. per* Square, but if the Workmen find Deals, 'tis worth from 24 *s.* to 30 *s. per* Square, which depends upon the goodness of the Deals.

Deal-Floors of Choice pick't Deals, laid either with Dufftail or Key-Joynts (without Pins or Nails) is worth 35 *s.* or 40 *s.* the Square.

Pallisado-Gates, &c. the Workman finding Wood, is worth 9 *s.* or 10 *s. per* Yard running measure, at about 6 or 7 Foot high, the working part is worth 6 or 7 *s. per* Yard.

Of the Rates and Prices of Brick-Work.

Bricks are worth from the Brick-Kiln about 12 Shillings *per* Thousand, which will nearly do a Rod of Work on a two Brick-Wall.

Building of Brick-Walls, the Workman finding Brick, Lime, and Sand, is worth as followeth, *viz.*

A Brick and a half Wall, 3 *s. per* Yard; A Two Brick-Wall, 4 *s. per* Yard; A Two Brick and a half Wall, 5 *s. per* Yard.

Brick-Walls, Building only, the Working part, is worth upon a Brick and half Wall, 4 *s. per* Rod, some places 3 *s.* 6 *d.* A Two Brick-Wall, 4 *s.* 6 *d.* or 4 *s.* 8 *d.* a Rod, and so proportionably, Six Yards to the Rod, which is all along to be understood in Brick-Walls.

A Chalder of Coals will burn about 4200 Bricks.

A Bricklayer with a Labourer, will lay about 1000 Bricks a Day.

Of the Rates and Prices of Tyling-Work.

Tyles are worth from 25 *s.* to 30 *s. per* Thousand; and may be laid on a Roof at about 3 *s. per* Square; some places 2 *s.* 6 *d.* or about 8 *s. per* Rod of 18 Foot Square.

Pan-Tyling is worth 5 *s.* 6 *d. per* Rod, Workmanship; and about 700, or 800 Tyles, doe 36 Yards, or a Rod.

Of the Rates and Prices of Slate-Work.

Slating, or covering a Roof with Slates, the Workman finding all Materials, is worth about 40 *s. per* Rod, *viz.* 36 Yards; but the Working part only is worth about 12 *s.* the Rod.

Slates, pointing, are worth 3 *s.* or 3 *s.* 6 *d. per* Rod, only the Working part.

Slates are worth at Pitts 12 or 14 *s.* a Thousand, which will nearly do a Rod, of 36 Yards.

Of the Rates and Prices of Plaisterers-Work.

Ceiling with Reed, Lime, and Hair (only Workmanship) is worth 3 *d. per* Yard, *viz.* 1 *d.* the Yard each Coat, but if the Workman find all, 'tis worth 5 *d.* or 6 *d.* a Yard.

Walls, drawing twice over, or two Coats, is worth 1 *d.* each, *viz.* 2 *d. per* Yard.

Plaister-Floors running, the Workman finding all, is worth 1 *s.* 4 *d. per* Yard, but the working part only is worth 4 *d.* 5 *d.* or 6 *d. per* Yard.

Plaister at the Pitts, may be had at 4 *s.* or 4 *s.* 6 *d. per* Load, *viz.* 40 C. Weight, which will do about 40 Yards of Flooring.

Rough-Casting upon the Fronts of Timber-Buildings, the Workman finding all Materials, is worth from 1 *s*, to 3 *s. per* Yard,

Yard, which depends upon the Variety and Goodneſs of the Work.

Of the Rates and Prices of Painting and Japan-Work.

White Painting is worth about 1 *s. per* Yard, Walnut-Tree-Painting is worth 1 *s.* 4 *d.* or 1 *s.* 6 *d. per* Yard; and ordinary-branch'd Painting is worth 12 *d.* 14 *d.* or 16 *d. per* Yard.

Japan-Work, plain, either black or white, is worth 3 *s.* 6 *d.* or 4 *s. per* Yard.

Gates and outward Doors are worth Painting 8 *d.* or 9 *d. per* Yard.

Of the Rates and Prices of Glaſiers-Work.

A Table of *New-Caſtle* Glaſs does contain about 5 Foot; 45 of which Tables make or go to a Caſe, which is worth from 25 *s.* to 40 *s.* the Caſe, and depends upon the Coal-Ships coming in.

Normandy Glaſs is much finer and clearer, of which 25 Tables make a Caſe, and is much dearer.

Glazing done with Quarries, or Diamond-Glaſs, is worth $\frac{1}{2}$4 *d.* or 5 *d. per* Foot.

Glazing with Squares is worth 6 *d. per* Foot, of *New-Caſtle* Glaſs.

Of the Rates and Prices of Plumbers-Work.

A Fodder of Lead is 22 Hundred Weight and an half, and is worth from 9 *l.* to 12 *l.* which will caſt 315 Foot of Sheet, at 8 pound in the Foot.

Sheet-Lead, and the Laying of it on in Roofing, *&c.* is worth 15 or 16 *s. per* Hundred Weight; if 14 *s. per* Hundred, then 1 *s. per* Foot, at 8 pounds in the Foot, is the ſame.

Old Lead Caſting into Sheet is worth 1 *s.* 6 *d. per* Hundred; but Caſting and Laying on a Roof is worth 2 *s.* the Hundred Weight: And here obſerve, that there is Loſs in Caſting of Lead, 2 *s.* 6 *d.* in every Hundred Weight.

Solder is uſually ſold at 9 *d.* the Pound.

Of the Rates and Prices of Stone-Cutters-Work.

Chimney-Pieces of *Egyptian*, or black ſleak'd Marble, or of Rance, or Liver-colour'd Marble, is worth (of an ordinary Size) 12 or 14 *l.* a Piece.

Window-Stools of white or black-ſleak'd Marble, are worth 2 *s.* 6 *d. per* Foot. Pavement of black or white Marble is worth about 2 *s. per* Foot, *&c.*

Of the Rates and Prices of Smiths-Work.

Caſements are worth 7 *d.* or 8 *d.* the Pound; ſome 9 *d. viz.* Folding Caſements.

Palliſado-Work, in Gates or otherways, is worth 4 *d.* the pound.

Of the Rates and Prices of Sawyers-Work.

Oak Sawing is worth 2 *s.* 8 *d. per* Hundred; ſome 3 *s.* to 3 *s.* 6 *d.* the Hundred.

Aſh Sawing is worth, in all reſpects, 6 *d.* a Hundred more than Oak.

The End of the Fifth BOOK.

THE

THE
Art of Surveying,
BOOK VI.

Containing the

DESCRIPTION and USE
OF A
NEW QUADRANT,

BEING

Plain and easie in Resolving the Hour and Azimuth, the Right Ascension; Declination, Oblique Ascension, and Descension of all Points of the ECLIPTICK; and thereby the Rising, Southing, and Setting of the

Planets and Fixed Stars,

The Sun's Rising and Setting, with the Increase and Decrease of the Days, to a Minute, and several other QUADRANTAL Performances on the Fore-side.

On the Back-side the QUADRANT are inserted Lines for Erecting of a Scheme of the Heavens for any time; and also Lines shewing the Diameter, Circumference, Area, and Square equal, of a Circle; with an Useful ALMANACK.

To which is Added,

A NEW TABLE of *Refractions* for Correcting the Sun, Moon, and Stars Altitude; As also a Table of Equations, for the Adjusting of *Pendulum* Clocks and Watches.

By *JOHN WING*, Math.

LONDON,

Printed for *Awnsham* and *John Churchill*, at the *Black Swan* in *Pater-Noster-Row*, MDCXCIX.

THE ART OF SURVEYING.

BOOK VI.

CHAP. I.

The Description and Inscription of the several Lines on the Fore-side of the Quadrant.

IN regard Mr. *Gunter*'s Quadrant has gained (and indeed worthily) the popular applause, for finding the Hour and Azimuth, I have therefore proceeded in the Calculation and Projection of the Hour and Azimuth-Lines, according to that Author's Method; the rest (the Ecliptick and Horizon excepted) has no relation to *Gunter*'s Quadrant, as is plain by what follows.

I. The Limb of the Quadrant (as in all others) is divided into 90 equal Parts call'd Degrees, and numbered by 10, 20, 30, &c. to 90, as being the 4th part of a Circle; the whole containing 360 Degrees.

II. Next above the Limb or 90 Degrees is placed a Line which is charactered at each end thereof R. A. being a Line of right Ascensions in time, shewing the R. A. of all points of the Ecliptick, in Hours and Minutes, being of Excellent Use in finding the Southing of the Planets and Fixed Stars, and may be projected into the Quadrant from this following Table of Right Ascensions, for 15 *gr.* in the Limb is 1 hour; 30, 2 hours, &c. And is numbered into Hours and Minutes, beginning at I, and ending at the other end at VI, which Divisions, backward and forward four times repeated, are Divided and Charactered into XXIV hours.

 III. The

Tabula Ascensionum Rectarum.

	♈				♉				♊			
	gr.	'	h.	'	gr.	'	h	'	gr.	'	h.	'
0	0	0	0	0	27	54	1	52	57	48	3	51
1	0	55	0	4	28	51	1	55	58	51	3	55
2	1	50	0	7	29	49	1	59	59	53	4	0
3	2	45	0	11	30	46	2	3	60	56	4	4
4	3	40	0	15	31	44	2	7	61	59	4	8
5	4	35	0	18	32	42	2	11	63	3	4	12
6	5	30	0	22	33	40	2	15	64	6	4	16
7	6	25	0	26	34	38	2	19	65	9	4	21
8	7	21	0	29	35	37	2	23	66	13	4	25
9	8	16	0	33	36	36	2	26	67	17	4	29
10	9	11	0	37	37	34	2	30	68	21	4	33
11	10	6	0	40	38	33	2	34	69	25	4	38
12	11	2	0	44	39	33	2	38	70	29	4	42
13	11	57	0	48	40	32	2	42	71	34	4	46
14	12	53	0	52	41	31	2	46	72	38	4	51
15	13	48	0	55	42	31	2	50	73	43	4	55
16	14	44	0	59	43	31	2	54	74	47	4	59
17	15	40	1	3	44	31	2	58	75	52	5	3
18	16	35	1	6	45	31	3	2	76	57	5	8
19	17	31	1	10	46	32	3	6	78	2	5	12
20	18	27	1	14	47	32	3	10	79	7	5	16
21	19	33	1	18	48	33	3	14	80	12	5	21
22	20	20	1	21	49	34	3	18	81	17	5	25
23	21	16	1	26	50	35	3	22	82	22	5	29
24	22	12	1	29	51	36	3	26	83	28	5	34
25	23	9	1	33	52	38	3	30	84	33	5	38
26	24	6	1	36	53	40	3	35	85	38	5	43
27	25	2	1	40	54	42	3	39	86	44	5	47
28	25	59	1	44	55	44	3	43	87	49	5	51
29	26	57	1	48	56	46	3	47	88	55	5	56
30	27	54	1	52	57	48	3	51	90	0	6	0

III. The next line (or rather two lines) marked at the Left-hand side with O A, and O D, and at the Right-hand side with O D, and O A, are lines of Oblique Ascensions and Oblique Descensions in time, being Applicable, for finding the Rising and Setting of the Planets and Fixed Stars, and may be inserted into the Quadrant, from the following Table of Oblique Ascensions, as it is here converted into Time, and by the help of the Ecliptick-Line, is numbered by I. II. &c. (backward and forward) to XXIV hours, and is inserted according to the XVth of this Chapter.

IV. The next or uppermost Line next the Hour-lines marked at either end with *Dec.* is a line of Declinations divided into Degrees, &c. Number'd by 10, 20; to 23 Deg. 29 Minutes, which is the Suns greatest Declination, and may be inserted into the Quadrant from the following Table of Declinations, and by the XVIth of this Chap.

V. The uppermost Line upon which the Hour-Lines abutteth is also the line for the Tropics of *Cancer* and *Capricorn* which the Horizon and Ecliptic crosses, in their respective places.

VI. The next line which includes the Hour-lines is the Equator, upon which the Hours and Azimuths fall and are number'd.

VII. Between the two lines, last explained and described, are placed the Ecliptic from the Equator, crossing the Zodiac to the Tropicks of ♋ and ♑ charactered, with the 12 Signs, each Sign divided into 30 Degrees, and number'd by 10, 20, 30. the division of which line is taken from the aforegoing Table of Right Ascensions; for 'tis but laying a Rular to the Center, and to 27 *gr.* 54′ in the Limb, and the point where the Rular crosseth the Ecliptick shall be the first point of ♉. In like manner the Right Ascension of the first point of ♊ is 57 or 48 Minutes. So if you lay a Rular to the Center, and 57 Degrees 48′ in the Limb, the point where the Rular crosseth the Ecliptick, shall be the first point of ♊, and so for every 10, and 5 Degrees, and Consequently every Degree, as you find it in the Table of Right Ascensions.

VIII. The Horizon also cometh from the same Point with the Ecliptick in the Equator, and falls upon the Tropicks, and is unequally divided into Degrees, and numbered by 10, 20, 30, &c. and by this following Analogy, you may find where the Horizon crosses the Tropicks for

As the *co. t.* of the Lat.	52°	00′	9.892810
to the *t.* of great. Dec.	23	29	9.637956
So the Radius	90	00	10.000000
to *s.* of Intersection	33	47	9.745146

Wherefore if you lay a Rular to the Centre, and to 33 *gr.* 47′. in the Limb, the point where the Rular crosseth the Tropick, is the Point where the Horizon falleth upon the Tropicks: Then find a point on the Right side of the Quadrant for the Centre to

Tabula Ascensionum Obliquarum Eclipticæ, ad Lat. 52°.

S. D.	gr.	'	h	'	S. D.	gr.	'	h	'	S. D.	gr.	'	h	'
♈. 0	0	0	0	0	♌. 0	94	6	6	16	♐. 0	265	54	17	44
4	1	37	0	6	4	99	42	6	39	4	271	26	18	6
8	3	15	0	13	8	105	22	7	2	8	276	50	18	28
12	4	55	0	20	12	111	4	7	24	12	282	8	18	50
16	6	35	0	26	16	116	49	7	47	16	287	16	19	9
20	8	18	0	33	20	122	35	8	10	20	292	15	19	29
24	10	4	0	40	24	128	22	8	33	24	297	2	19	48
28	11	53	0	48	28	134	8	8	56	28	301	36	20	6
♉. 2	13	45	0	55	♍. 2	139	54	9	20	♑. 2	305	58	20	24
6	15	42	1	3	6	145	40	9	43	6	310	7	20	41
10	17	45	1	11	10	151	24	10	6	10	314	1	20	56
14	19	52	1	20	14	157	8	10	29	14	317	41	21	11
18	22	8	1	29	18	162	52	10	52	18	321	9	21	25
22	24	31	1	38	22	168	35	11	14	22	324	24	21	38
26	27	2	1	48	26	174	18	11	37	26	327	26	21	50
♊. 0	29	42	1	59	♎. 0	180	0	12	0	♒. 0	330	8	22	1
4	32	34	2	10	4	185	42	12	23	4	332	58	22	12
8	35	36	2	22	8	191	25	12	46	8	335	29	22	22
12	38	51	2	36	12	197	8	13	9	12	337	52	22	31
16	42	19	2	49	16	202	52	13	32	16	340	8	22	40
20	45	59	3	4	20	208	36	13	54	20	342	15	22	49
24	49	53	3	20	24	214	20	14	17	24	344	18	22	57
28	54	2	3	36	28	220	6	14	40	28	346	15	23	5
♋. 2	58	24	3	54	♏. 2	225	52	15	4	♓. 2	348	7	23	13
6	62	58	4	12	6	231	38	15	26	6	349	56	23	20
10	67	45	4	31	10	237	25	15	50	10	351	42	23	27
14	72	44	4	51	14	243	11	16	13	14	353	25	23	34
18	77	52	5	12	18	248	56	16	36	18	355	5	23	40
22	83	10	5	33	22	254	38	16	59	22	356	45	23	47
26	88	34	5	54	26	260	18	17	21	26	358	23	23	45

Tabula

Tabula Declinationum.

	♈ ♎		♉ ♍		♐ ♊		
D.	gr.	'	gr	'	gr.	'	D.
0	0	0	11	30	20	11	30
1	0	24	11	50	20	24	29
2	0	48	12	11	20	36	28
3	1	12	12	31	20	48	27
4	1	36	12	52	20	59	26
5	2	0	13	12	21	11	25
6	2	24	13	32	21	21	24
7	2	47	13	52	21	31	23
8	3	10	14	12	21	41	22
9	3	34	14	31	21	51	21
10	3	57	14	50	22	0	20
11	4	21	15	9	22	8	19
12	4	45	15	27	22	17	18
13	5	19	15	46	22	25	17
14	5	32	16	4	22	32	16
15	5	55	16	22	22	39	15
16	6	18	16	39	22	45	14
17	6	41	16	56	22	51	13
18	7	4	17	13	22	57	12
19	7	27	17	30	23	2	11
20	7	50	17	46	23	7	10
21	8	12	18	2	23	11	9
22	8	35	18	18	23	15	8
23	8	57	18	33	23	18	7
24	9	20	18	48	23	21	6
25	9	42	19	3	23	24	5
26	10	4	19	17	23	26	4
27	10	25	19	31	23	27	3
28	10	47	19	45	23	28	2
29	11	8	19	58	23	29	1
30	11	30	20	11	23	29	0
	♓ ♍		♒ ♌		♑ ♋		

to draw the Arch of the Horizon from, that it may fall upon the limited Points in the Tropicks and Equator.

For the Division of the Horizon use this Analogie.

As the Rad.	90°	00'	10.000000
to the *s.* of the Latitude	52	00	9.896532
So the *t.* of the Horizon, *viz.*	10	00	9.246319
to the *t.* of the Arke in the Limb.	7	59	9.142851

*Wherefore lay a Rular to the Centre, and to 7 Deg. 59 Min. in the Limb, and where the Rular crosseth the Horizon, shall be the Division of 10 Deg. in the Horizon, and so for the rest.

A Table of the Sun's Altitude at all Hours of the Day, at the Suns entrance into any of the XII Signs, and at every Tenth Degree thereof.

Ho. before		N.		XII.		XI.	I.	X.	II.	IX.	III.	VIII.	IV.	VII.	V.	VI.		V.	VII.	IV.	VIII.
Ho. after		N.																			
S.	D.	S.	D.	°	'	°	'	°	'	°	'	°	'	°	'	°	'	°	'	°	'
♋	0	♋	0	61	30	59	58	53	21	45	51	36	36	27	23	18	19	9	39	1	48
	20		10	61	7	58	53	53	5	45	11	36	18	27	6	18	0	9	21	1	29
	10		20	60	0	57	50	52	7	44	18	35	28	26	16	17	9	8	27	0	32
♊	0	♌	0	58	13	56	6	50	33	42	52	34	1	24	57	15	48	7	3		
	20		10	55	47	53	47	48	25	40	54	32	14	23	5	13	54	5	5		
	10		20	52	52	50	58	46	49	38	30	29	57	20	50	11	38	2	44		
♉	0	♍	0	49	30	47	43	42	48	35	42	27	18	18	18	9	2	0	3		
	20		10	45	51	44	9	39	27	32	35	24	20	15	21	6	9				
	10		20	42	0	40	23	35	54	29	16	21	12	12	26	3	8				
♈	0	♎	0	38	0	36	29	32	13	25	48	17	6	9	10						
	20		10	34	2	32	36	28	21	22	19	14	38	6	0						
	10		20	30	11	28	49	24	54	18	55	11	24	2	54						
♓	0	♏	0	26	30	25	12	21	27	15	31	8	19	0	56						
	20		10	23	9	21	55	18	17	12	39	5	30								
	10		20	22	41	19	2	15	31	10	2	3	2								
♒	0	♐	0	17	49	16	38	13	14	7	52	0	59								
	20		10	16	0	14	52	11	31	6	15										
	10		20	14	53	13	46	10	28	5	15										
♑	0			14	30	13	21	10	3	4	51										

IX. The Hour-lines are included between the Equator and Tropicks, and are Character'd with Letters at the Equator, respecting the several Hours for the Morning, and with Figures at the Tropicks giving the Denomination to each Hour after Noon, both for the Summer and Winter-Hours, where Note, that the Hours

Hours for the Summer half Year extend themſelves toward the Right-hand, and the Hours for the Winter half Year to the Left-hand; theſe Hour-lines are drawn upon the Quadrant from this Table of the Sun's Altitude, which muſt be taken in three ſeveral Places, *viz.* in the Equator, Tropicks, and ſome one Parallel of Declination, hence obſerve for the inſerting the ſeveral Hour-lines into the Quadrant, that if you lay a Rular to the Centre, and to 61 Deg. 30′ in the Limb, Obſerve then where it croſſes the Tropick, and there make a Prick: then move the Rular to 49 Deg. 30′ and Note where it croſſeth the Parallel of ♉ (the Sun there hath 11° 30′ of Declination, which is the Parallel of Declination we here make uſe of) and there make a Second Prick: Again lay the Rular from the Centre to 38 Deg. in the Limb, and where it croſſeth the Equator make a third Prick, now find a Centre to theſe three Pricks, which brings them all into an Arch-line which ſhall be the Hour-line for 12 a Clock in the Summer, obſerve the ſame Method for all the reſt of the Hours in the Summer half Year, and alſo for thoſe in the Winter. Note alſo that the Hours for 5 and 7, and 4 and 8, which Points fall between the Equator and Tropicks, thoſe Points of the Summer and Winter-Hours meeting are beſt found (which fall by the edge of the Quadrant) by the line of Declinations, for 'tis but laying the String on the Degree of Declination, then bring the Bead to the Ecliptick, anſwerable to the Days of the Month that the Sun Riſes at 4 and 5 in the Summer, or Sets at 4 and 5 in Winter (all which agrees) then move the String to the Left edge of the Quadrant, and there where the Bead falls is the Points for the ſaid Hour-lines, and ſhews alſo the lines, or Points of the Sun's Riſing and Setting, for 5 and 7, and 4 and 8.

A Table of the Altitude of the Sun in the beginning of each Sign for every 10*th Azimuth. Latit.* 52. *Degrees.*

Azimuth		10	20	30	40	50	60	70	80	90
	Merid.	gr. ′	gr. ′	gr. ′	gr. ′	gr. ′	gr. ′	gr. ′	gr. ′	gr ′
♋	61 30	61 14	60 22	58 52	56 38	53 33	49 29	44 14	37 58	30 24
♊	58 12	58 54	56 28	56 22	53 0	49 43	44 25	40 0	33 28	26 0
♉	49 30	49 9	48 3	46 11	43 26	39 44	34 58	29 6	22 15	14 40
♈	38 0	37 35	36 17	34 5	30 54	26 40	21 20	14 57	7 44	0 0
♓	26 30	26 1	24 31	22 0	18 22	13 26	7 42	0 48	6 46	
♒	17 48	17 16	15 36	12 48	8 49	3 37	2 45	10 6	18 0	
♑	14 30	13 56	12 12	9 18	5 10	0 13	6 49	14 19	22 30	

X. The Azimuth lines are placed on the Right-ſide the Quadrant, as the Hour-lines are on the left, and are drawn to every 10th Azimuth and Numbered by 10, 20, 30, 40, &c. to 120, and are inſerted from this Table of the Sun's Altitude in the beginning of each Sign for every 10th Azimuth, and according to the ſame

Method the Hour-lines were from the former Table, for you must find by this Table, where each 10th Azimuth falls upon the Equator, Tropicks, and some Parallel of Declination. As suppose you would draw the 10th Azimuth from the Meridian, lay a Rular to the Centre and to 61 Deg. 14′ in the Limb, and where the Rular crosseth the Tropick there make a prick; then move the Rular to 37 Deg. 55′ in the Limb, and where it crosseth the Equator make a second prick; then lay the Rular in the Limb to 49 Deg. 9′ and where it crosseth the Parallel of ♉ (being the Parallel here made use of) make a third Prick; these three Pricks drawn into a Circle shall be the Azimuth line of 10 Deg. from the Meridian as was requir'd, observe the like for the rest.

XI. There is placed on either side the Ecliptick several fixed Stars, with their Names affixed to them, and are placed according to their Declination from the Equator, and fitted to the Longitude of this Age, whose Longitude, Latitude, and Declination are as in this Table, from which they may be inserted into the Quadrant, according to these following directions.

Names of the Stars.	Longitude.			Latitude.			Declination.		
	S.	°	′	°	′		°	′	
Pleiades.	♉	25	47	4	0	N.	22	58	N.
Aldebaran.	♊	5	35	5	31	S.	15	45	N.
Sirius.	♋	9	58	39	30	S.	16	13	S.
Cor Leonis.	♌	25	40	0	26	S.	13	41	N.
V. Spick.	♎	19	49	1	59	S.	9	16	S.
Arcturus.	♎	20	2	31	2	N.	21	6	N.
S. Ballance.	♏	10	54	0	26	N.	14	30	S.

Let it be required to place *Aldebaran* in the Quadrant according to his Longitude, and Declination: First, lay the Thread upon 15° 45′ (being his Declination) in the line of Declinations, it resting there, bring the bead to the Ecliptick, which done move the String to 5° 35′ ♊ his place in Longitude, and where the Bead falls is the place where you are to place the Star *Aldebaran*: Observe the same Method for the rest, or for any other Stars you have a mind to fix upon your Quadrant.

XII. The Months are placed in the Circular lines above the Equator, each Month and Day being fitted to the Sun's place in the Ecliptick, and for inserting them into their several Circles in the Quadrant, 'tis but laying the Thread to the Sun's place in the Ecliptick answerable to each Month and Day, and so make their Divisions in their respective Circles: As suppose you would put on the 1st Day of *March*, the Sun's place that Day at Noon is 21 Deg. 30′ ♓, upon which point of the Ecliptick lay the Thread, and where it falls in the Circle of Months make a Mark for the first Day of *March*: Again, let it be required to put on the 30th Day of *March*, the Sun that Day is in 20 Deg. of ♈, to which point

point in the Ecliptick bring the Thread, and where it falls in the Circle of Months, make a Mark for the 30th Day of *March*; observe this Method for all the Months and Days in the Year.

XIII. On the Left-side the Quadrant is placed between the Tropicks and Equator, a double line shewing the time of Sun's rising and setting to a Minute for every Day in the Year, and may be graduated upon the Quadrant from this following Table; for if the Thread be laid to the Day of the Month, and the Bead brought to the Ecliptick; then move the String to the side of the Quadrant, and there where the Bead falls, put down the Suns rising and setting according to the time from the Table: Where Note it being doubly to be understood according to the time of the Year, for it may be either the time of the Sun's Rising in the Summer, or his Setting in Winter, as 8 may be his Rising in Winter, and Setting in Summer, and 4 may be his Rising in Summer, and Setting in Winter; which is all one line upon the Quadrant, and if you look in the Table on the 3d day of *January*, you will find the Sun that Day to Rise at 8 in the Morning, and Sett at 4 in the Afternoon (where Note that the Suns *Semi-Nocturnal* Arch shews the time of his Rising, and his *Semi-Diurnal* Arch the time of his Setting). Again, the 16 Day of *May*, the Sun Sets at 8 at Night, and rises at 4 in the Morning, and likewise *July* the 6th Day the Sun Rises at 4 and Sets at 8, and also the 17th day of *November* he Rises at 8 in the Morning and Sets at 4 After Noon; So that laying the String (in the Quadrant) upon either of the aforenamed days (for the laying the String upon any one of them, it will at the same time fall on all the rest) and bring the Bead to the Ecliptick, then move the String to the Left-side of the Quadrant and where the Bead falls, there draw a line for the Sun's Rising and Setting as before; and so accordingly for the rest.

XIV. On the Right-side of the Quadrant, between the Tropicks and Equator, is another double line, shewing how many Hours and Minutes the days are Increased or Decreased, which Line discovers every day in the Year to one Minute, and may be inserted into the Quadrant, from this following Table, for the Thread being laid to what Month and Day you please, and there bring the Bead to the Ecliptick, then look in the Table for the same Month and Day, and by moving the Thread to the Right-side, and where the Bead falls, put on the Increase or Decrease of the Days at that time as you find it by the Table: As, suppose the Days be increased 2 Hours which in the Table you will find on the 31st Day of *January*, and there bring the Bead to the Ecliptick, then move the String to the Right-side of the Quadrant, and where the Bead falls, draw a line (or likewise the 4th Day of *August* when the Days are Decreased 2 hours, for this line serves for both the Increase or Decrease of the Days, as may be discovered by the Table) and this line so drawn shews the Day to be Increased 2 Hours, if it be the 30th of *January*, or

A Table of the Sun's Semi-{Diurnal / Nocturnal} *Arch for the Latitude of* 52 *Degrees.*

	Jan.		*Feb.*		*Mar.*		*April.*		*May.*		*June.*	
D.	*h.*	′	*h.*	′	*h.*	′	*h.*	′	*h.*	′	*h.*	′
1	8	Noct. 2	7	13	6	17	6	44	7	39	8	13
2	8	1	7	11	6	15	6	46	7	41	8	13
3	8	0	7	9	6	13	6	48	7	42	8	14
4	7	59	7	7	6	11	6	50	7	43	8	14
5	7	58	7	5	6	9	6	52	7	45	8	14
6	7	56	7	3	6	7	6	54	7	46	8	15
7	7	55	7	1	6	5	6	56	7	48	8	15
8	7	53	7	0	6	3	6	58	7	50	8	15
9	7	52	6	58	6	1	7	0	7	51	8	15
10	7	51	6	56	6	Diur. 1	7	2	7	53	8	15
11	7	50	6	54	6	3	7	4	7	55	8	15
12	7	48	6	52	6	5	7	6	7	56	8	15
13	7	46	6	50	6	7	7	8	7	57	8	15
14	7	45	6	48	6	9	7	10	7	58	8	15
15	7	43	6	46	6	11	7	12	7	59	8	15
16	7	42	6	44	6	13	7	14	8	0	8	14
17	7	41	6	42	6	15	7	16	8	1	8	14
18	7	39	6	40	6	17	7	17	8	2	8	14
19	7	38	6	38	6	19	7	19	8	3	8	13
20	7	36	6	36	6	20	7	21	8	4	8	13
21	7	34	6	34	6	22	7	23	8	5	8	12
22	7	32	6	32	6	24	7	25	8	6	8	11
23	7	30	6	29	6	26	7	27	8	7	8	11
24	7	28	6	27	6	28	7	28	8	8	8	10
25	7	27	6	25	6	30	7	30	8	8	8	9
26	7	25	6	23	6	32	7	31	8	9	8	9
27	7	23	6	21	6	34	7	33	8	9	8	8
28	7	21	6	19	6	36	7	34	8	10	8	8
29	7	19			6	38	7	37	8	11	8	7
30	7	17			6	40	7	38	8	11	8	6
31	7	15			6	42			8	12		

A Table

A Table of the Sun's Semi-{Diurnal / Nocturnal} *Arch for the Latitude of* 52 *Degrees.*

	July.		*Aug.*		*Sep.*		*Octob.*		*Nov.*		*Dec*	
D.	*h.*	'	*h*	'	*h.*	'	*h*	'	*h.*	'	*h.*	'
1	8	6	7	21	6	22	6	39	7	38	8	12
2	8	5	7	19	6	20	6	41	7	39	8	13
3	8	4	7	17	6	18	6	43	7	41	8	13
4	8	2	7	16	6	16	6	45	7	42	8	14
5	8	1	7	14	6	14	6	47	7	43	8	14
6	8	0	7	12	6	12	6	49	7	45	8	14
7	7	59	7	10	6	11	6	51	7	46	8	15
8	7	58	7	8	6	8	6	53	7	48	8	15
9	7	56	7	6	6	6	6	55	7	50	8	15
10	7	55	7	4	6	3	6	57	7	51	8	15
11	7	53	7	2	6	1	6	59	7	52	8	15
12	7	52	7	0	6	Noct. 0	7	0	7	53	8	15
13	7	51	6	59	6	1	7	2	7	55	8	15
14	7	50	6	57	6	3	7	4	7	56	8	15
15	7	48	6	55	6	6	7	6	7	58	8	15
16	7	46	6	54	6	8	7	8	7	59	8	14
17	7	45	6	52	6	11	7	10	8	0	8	14
18	7	43	6	50	6	12	7	12	8	1	8	14
19	7	42	6	48	6	14	7	14	8	2	8	13
20	7	41	6	46	6	16	7	16	8	4	8	13
21	7	39	6	44	6	18	7	17	8	5	8	12
22	7	40	6	42	6	20	7	19	8	6	8	11
23	7	38	6	40	6	22	7	21	8	7	8	11
24	7	37	6	38	6	24	7	23	8	8	8	10
25	7	35	6	36	6	26	7	25	8	8	8	9
26	7	33	6	34	6	28	7	27	8	9	8	9
27	7	31	6	32	6	31	7	28	8	9	8	8
28	7	29	6	30	6	33	7	30	8	10	8	8
29	7	27	6	28	6	35	7	32	8	11	8	7
30	7	25	6	26	6	37	7	34	8	11	8	6
31	7	23	6	24			7	36			8	5

A Table shewing the Increase and Decrease of the Days for the Latitude of 52 Degrees, for the first Six Months of the Year.

Days.	Jan. h.	Jan. '	Feb. h.	Feb. '	Mar. h.	Mar. '	April. h.	April. '	May. h.	May. '	June. h.	June. '
1	0	26	2	3	3	56	5	58	7	49	8	55
2	0	28	2	7	4	0	6	2	7	52	8	56
3	0	30	2	11	4	4	6	6	7	55	8	57
4	0	32	2	15	4	8	6	10	7	58	8	58
5	0	34	2	19	4	12	6	14	8	1	8	59
6	0	37	2	23	4	16	6	18	8	4	8	59
7	0	40	2	26	4	20	6	22	8	7	8	59
8	0	43	2	30	4	24	6	26	8	10	9	0
9	0	46	2	34	4	28	6	30	8	13	9	0
10	0	49	2	38	4	32	6	34	8	16	9	0
11	0	52	2	42	4	36	6	38	8	19	Days.	Dec.
12	0	55	2	46	4	40	6	41	8	22	0	0
13	0	58	2	50	4	44	6	45	8	24	0	0
14	1	1	2	54	4	48	6	49	8	26	0	0
15	1	4	2	58	4	52	6	53	8	28	0	1
16	1	7	3	2	4	56	6	57	8	30	0	1
17	1	10	3	6	5	0	7	0	8	32	0	2
18	1	13	3	10	5	3	7	4	8	34	0	2
19	1	16	3	14	5	7	7	8	8	36	0	3
20	1	20	3	18	5	11	7	12	8	38	0	4
21	1	23	3	22	5	14	7	15	8	40	0	5
22	1	26	3	26	5	18	7	19	8	42	0	6
23	1	29	3	30	5	22	7	23	8	43	0	7
24	1	32	3	35	5	26	7	27	8	45	0	9
25	1	36	3	39	5	30	7	31	8	46	0	10
26	1	40	3	44	5	34	7	34	8	48	0	11
27	1	44	3	48	5	38	7	37	8	49	0	12
28	1	48	3	52	5	42	7	40	8	51	0	14
29	1	52			5	46	7	53	8	52	0	16
30	1	56			5	50	7	46	8	53	0	18
31	2	0			5	54			8	54		

A Table shewing the Increase or Decrease of the Days for the Latitude of 52 Degrees, for the last Six Months of the Year.

	July.		*Aug.*		*Sep.*		*Octob.*		*Nov.*		*Dec.*	
D.	*h.*	′	*h.*	′	*h.*	′	*h.*	′	*h.*	′	*h.*	′
1	0	20	1	48	3	46	5	48	7	46	8	54
2	0	22	1	51	3	50	5	52	7	49	8	55
3	0	24	1	55	3	54	5	56	7	52	8	56
4	0	26	1	59	3	58	6	0	7	55	8	57
5	0	28	2	2	4	2	6	4	7	58	8	58
6	0	30	2	6	4	6	6	8	8	0	8	59
7	0	32	2	10	4	10	6	12	8	3	8	59
8	0	34	2	14	4	14	6	16	8	6	9	0
9	0	37	2	18	4	18	6	20	8	9	9	0
10	0	39	2	22	4	22	6	24	8	12	9	0
11	0	43	2	25	4	26	6	28	8	14	Days Incr.	
12	0	46	2	29	4	30	6	32	8	17	0	0
13	0	48	2	33	4	34	6	36	8	19	0	0
14	0	51	2	36	4	38	6	39	8	22	0	0
15	0	54	2	40	4	42	6	43	8	25	0	0
16	0	57	2	43	4	46	6	47	8	28	0	1
17	1	0	2	47	4	50	6	50	8	30	0	1
18	1	3	2	51	4	54	6	54	8	33	0	2
19	1	6	2	54	4	58	6	58	8	35	0	3
20	1	9	2	58	5	2	7	2	8	38	0	4
21	1	12	3	2	5	7	7	6	8	40	0	5
22	1	15	3	6	5	11	7	9	8	42	0	6
23	1	18	3	10	5	15	7	13	8	44	0	7
24	1	21	3	14	5	19	7	17	8	46	0	9
25	1	24	3	18	5	23	7	20	8	48	0	10
26	1	27	3	22	5	27	7	24	8	49	0	11
27	1	30	3	26	5	32	7	28	8	50	0	13
28	1	33	3	30	5	36	7	31	8	51	0	15
29	1	36	3	34	5	40	7	35	8	52	0	16
30	1	40	3	38	5	44	7	39	8	53	0	18
31	1	44	3	42			7	42			0	20

Decreased 2 hours, if it be the 4th Day of *August*, and by this Method you may put on all the rest from this Table.

XV. To insert the Oblique Ascensions in time into the Quadrant, First lay the Thread to 4 Deg. 30 Min. ♉, in the Ecliptick (which in the Table of O A. *Page* 278, gives 1 Hour) and where the String crosseth the line of O A. make a Mark for 1 Hour, being the O A in time agreeing to 4° 30′ ♉; Likewise you may find by the Table that 0° 15′ ♊ gives the O A, two Hours, wherefore lay the String to 0° 15′ ♊, and where it crosseth the line of the Oblique Ascensions, there make a Mark for 2 Hours: Again the String laid to 18° 50′ ♊, where it falls in the line of O A make a mark for 3 Hours, and thus may the Table direct you to put on the rest.

XVI. For the Inscribing the line of Declinations into the Quadrant in Degrees, do thus, lay the Thread to 2 Deg. 30 Min. ♈, and where the Thread crosses the line of the Declinations, there make a mark for 1 Deg. of Declination: Again lay the Thread to 5 Deg. ♈, and where the String then crosseth the line of Declinations make another mark for 2 Deg. of Declination, and so the rest, as the Table of Declinations *Page* 279 directs.

XVII. There is a Thread and Plummet to be put to the Quadrant with a small Bead upon the Thread to be moved up and down as occasion requires, there are also a pair of Sights with little holes in them fixed on the Right-side of the Quadrant, so it is fitted for use.

Note that by the aforegoing Tables and Directions may a Quadrant be made to what Radius you please.

CHAP. II.

The Use of the Degrees in the Limb of the Quadrant, in takeing of Altitudes.

PROP. I.

To find the Altitude of the Sun.

HOld up the Quadrant, so that the Sun-beams may pass thro' both the Sights, holding the Quadrant also in that posture, that the Thread with the Plummet may play easily by the side of it, Then observe the Degrees cut by the Thread in the Limb of the Quadrant, which is the Altitude of the Sun required.

EXAMPLE I.

Suppose on the 11th day of *June* at Noon, the Sun-beams passing through the Sights, the Thread falling upon 61 Degrees 30 Min. in the Limb, so much then is the Sun's Altitude, it being also the

the greatest Meridian Altitude of the Sun in the Latitude of 52 Degrees.

EXAMPLE II.

Suppose the same day at 4 after Noon, the Thread fall upon 28 Degrees in the Limb (by holding the Quadrant as before directed) such then was the Altitude of the Sun at that Time.

PROB. II.

To find the Altitude of a Star by Night.

Suppose at any time of the Night I espie a Star upon the Meridian or any other place in the Heavens, and desire to know the Altitude thereof; hold up the Quadrant so that the Thread and Plummet may have free liberty to Play by the side of the Quadrant, and looking at the Star through the Sights, then will the Thread in the Limb fall on the Degrees of Altitude, of the said Star, which being so easy it needs no Example.

PROB. III.

To find the Altitude of a Steeple, Tower, Tree, or the like.

The Steeple, &c. Standing upon a Level from you; if not, you must first find where the Level falls from your Eye to the Steeple, &c. Then hold the Quadrant to your Eye, and go backwards or forwards, till the String fall upon 45 Degrees in the Limb; Then add the height from your Eye to the Ground, to your Standing, backwards, and from that place to the Steeple, is equal to the height of the Steeple the thing required.

Note that if the String fall on 22*gr.* 30′, the height is but half the distance: And contrary, if the Thread fall on 67*gr.* 30′ the height is double the said distance, but if the distance given be more or less, the Case must be resolved by the Doctrine of a plain Right-Angled Triangle.

EXAMPLE.

Suppose the distance be 265 Foot, at which distance I look through the Sights of the Quadrant, to the top of the Steeple or Tower, and find the Thread to fall upon 25 Degrees in the Limb.

Then Say

As the Radius, 90*gr.*	10.000000
to the Tang. of 25*gr.*	9.668672
So the Distance, 265 Foot.	2.423246
to the Height required, 123.57 Foot.	2.091918

PROB. IV.

The distance being given, to find the Hypothenuse, or distance from the Eye to the top of the Steeple.

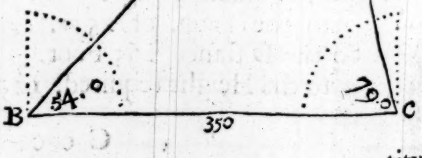
Let the distance as in the last Example be 265 Foot, and the Angle at the Eye (as before) 25 Degrees, Hence the Analogy is.

As the Co-sine of $25^{\circ}\ 00'$	9.957296
to the Radius, 90°.	10.000000
So the Distance, 265 Foot	2.423246
to 292.40 Foot, the Hypothenuse required	2.465970

To the former Problems of *Altimetria*, I shall annex a Problem or two of *Longimetria*, whereby the distance of any such Places upon the Earth, that lye within the View of the Eye, may be found out and determined by the Solution of right-lined Triangles, and also by Projection, as we shall afterward shew; which will be most excellent and useful for Surveyors, Engineers, Miners, and such like, who may hereby perform many notable exploits in Militarie affairs, as Springing of Mines, approaching to Forts and Castles, and making Batteries: Neither can the Geographer be perfect in his Work, without a competent knowledge therein, for by the help thereof, a whole Region or Country may exactly be described, and all such Towns, Rivers, Marshes, and other remarkable Places lying within the same, may hereby be laid down in their due Place and Order; and if there be any errours in such Maps and Chards as are already extant, they may hence be corrected, as the Ingenious Artist will sooner find by Practice, than by many Words, and therefore I shall not make any tedious preamble but shall come to that which I intend upon this matter.

PROB. V.

The Interval of two Stations being given, with the Quantity of the Angle at each Station, to find the Distance.



Suppose from some private place, as B, you espy a Castle, but for fear of Gun-shot, Moorish ground or some other Impediments, you cannot have an opportunity to make your second Station in any open place, but are forced to make it in some other secure place, as at C: In this case having planted your Instrument at B, and directed the Sights to A and C, take the quantity

tity of the Angle A B C, 54 Deg. 0 Min. and the quantity of the Angle A C B, 79 Deg. 0 Min. Which known, with the Interval of the two Stations B and C, 350 Yards, I say by the 4th Problem of the Third Book, *Sect.* 2.

1. To find B A.

As the sine of the Angle B A C, 47 D. 0 M.	9.86413
To B C, 350 Yards	2.54407
So the sine of the Angle A C B, 79 D. 0 M.	9.99194
	12.53601
To the Distance B A, 469.77	2.67188

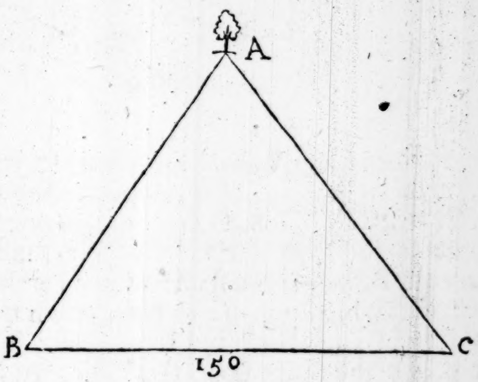
2. To find C A.

As the sine of the Angle B A C, 47 D. 0 M.	9.86413
To B C, 350.	2.54407
So the sine of the Angle A B C, 54 D. 0 M.	9.90796
	12.45203
To A C the distance required, 387.17	2.58790

PROB. VI.

To take the Distance of a Place at two Stations, by the Plain-Table.

Having made choice of the place of your first Station, as at B, there plant your Table, and direct your Sights to the Tree at A: Next direct the sights of your Index to the place of the second Station at C, and from B strike lines towards A and C: Then with your Chain, measure the Interval of the two Stations B and C, 150 Yards: Then plant your Table at C, where you may see both the Tree and your first Station, and screwing fast the Table, lay the Index upon the line B C; which done, turn the Table gently about, till through the Sights you see the place of your first Station at B; then fixing the Table turn the Index about upon the point C, and directing the



Sights thereof to A, strike a line by the edge of the Rular, and where it intersects the line A B (as at A) there make a marke;

then open your Compasses to the extent B A. which being applied to the same Scale, by which you laid down the Stationary distance, you shall find the distance B A 124 Yards, and the distance C A 135 Yards.

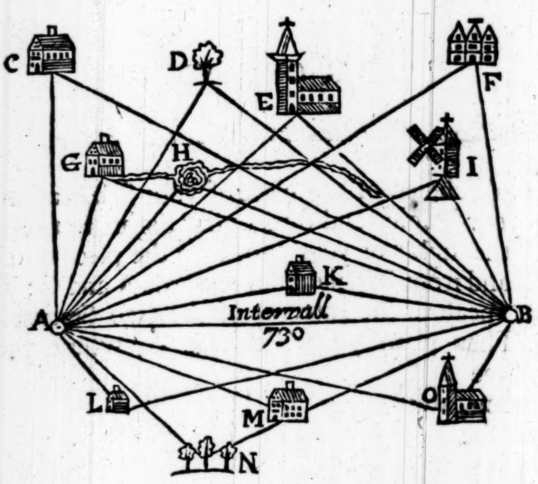
But it is to be noted (in Works of this Nature) that the larger the Interval of the Stations are, the more exactly will the distance be found.

PROB. VII.

To take the distance of divers Places remote from You, by the help of two Stations.

This Problem serveth chiefly to describe upon Paper or Parchment, all the most Eminent and Remarkable places in a Country, Town, or City, whereby a Map thereof may be exactly made, as with a little Practice you may soon perceive.

Upon some Hill, or high piece of Ground, make choice of two Stations as A and B, from whence you may plainly discern all the principal Places which you intend to describe in your Map: Then at A plant your Table, and direct the Sights of the Index to B;



which done (your Table being fixed) set your Index upon the point A, upon which, turning it about, direct the sights severally to C, G, D, H, E, F, I, K, O, M, N, L, to every of which places, strike a line by the edge of the Rule: Next measure the Stationary distance A B, which you shall find 730 Perches, or two Miles and 90 Perches, which you are to place down from A to B, by the Assistance of your Scale and Compasses; Then planting the Table at B, lay the Index upon the Stationary line A B, and then turn the Table, till through the Sights you espie the place of your first Station at A, in which posture (the Table standing fixed) direct your

your sights again from B to all the former points, and where these and the lines drawn from A Intersect each other, there must you describe the several Places, to which you made observation, where you may write the name of the Place, as you see convenient.

Lastly, if you would know the distance of any of the places thus describ'd, one from another, you have no more to do, but to open your Compasses, to the two places upon the Paper, and then applying it to the same Scale, by which you laid down the Stationary distance, it will, without any further trouble, effect your desire. And thus much briefly touching this matter.

CHAP. III.

The Use of the Ecliptick-line.

PROB. I.

The place of the Sun being given to find his Right Ascension.

THE Ecliptick-line is known by the Characters of the 12 Signs, as ♈, ♉, ♊, &c. each Sign being unequally divided into 30 Degrees, and to be accounted according to the order and Succession of the Signs.

Lay the Thread on the Sign and Degree of the Sun's place in the Ecliptick, and the Degrees the String then cuts in the Limb is the Right Ascension required.

EXAMPLE. I.

Suppose the place of the Sun given be 25 Degrees of ♈, the Thread laid thereon, cutteth in the Limb 23 Deg. 9 Min. which is the Right Ascension of the Sun at that time.

But if the place of the Sun be more than three Signs, or 90 Deg. from the beginning of ♈, then more must be allowed than 90 Degrees to the Right Ascension, in respect this Instrument is but a Quadrant.

EXAMPLE II.

Admit the Sun be in 5 Deg. of ♌; the String laid thereto, cutteth in the Limb 127 Deg. 22 Min. that is the whole Limb 90 Deg. and back again 37 Deg. 22 Min. which makes 127 Deg. 22 Min. the Sun's Right Ascension, as was required.

PROB.

PROB. II.

The R. A. *of the Sun, being given, to find his place in the* Ecliptick.

Lay the Thread on the R. A. in the Limb of the Quadrant, and without more adoe, it crosseth the place of the Sun in the Ecliptick; This in all respects is only the converse of the former, so needs no example to explain it.

CHAP. IV.

The Use of the Horizon.

PROB. I.

The Sun's place, or day of the Month being given, to find the Amplitude of the Sun's Rising and Setting.

LAY the Thread to the day of the Month, and bring the Bead to the Ecliptick; which done, move the String till the Bead fall upon the Horizontal line, and there it will shew the Amplitude required.

EXAMPLE.

Admit the Day given be the 26th day of *May*, the Sun being then in 15° 40′ ♊, the Bead rectified and brought to the Horizon, doth there fall upon 38 Deg. 50 Min. which is the Amplitude of the Sun's Rising from the *East*, and setting from the *West*.

Where Note that the said Amplitude is always *North* when the Sun is in *Northern* Signs, and *South* when he is in *Southern*.

PROB. II.

The Sun's place or day of the Month given, to find the Ascensional Difference.

Rectifie the Bead for the time; which done, bring it to the Horizon, so the Degrees the Thread falls on in the Quadrant, shews the difference of Ascensions.

EXAMPLE.

The 26th Day of *May*, the Sun being in 15° 40 ♊, the Bead Rectified and brought to the Horizon, sheweth the Ascensional difference to be 31° 17′.

CHAP.

CHAP. V.

The Use of the Hour-lines.

PROB. I.

The Day of the Month being given, to find the Hour of the Day.

LAY the Thread to the day of the Month, then bring the Bead to the Ecliptick, so is the Quadrant rectified for use, then hold the Quadrant, so as the Sun may Dart his Rays thro' both the Sights, the Thread and Plummet playing easily by the side of the Quadrant, so will the Bead fall upon the Hour of the Day.

EXAMPLE.

On the 28th Day of *April* (the Bead being Rectified as above) I hold the Quadrant so as the Sun-Rays may pass through both the Sights; I find the Bead to fall upon the Hour-line of IX and III, so that if the Observation was made in the forenoon it was 9 of the Clock, if in the afternoon 3.

PROB. II.

The Altitude of the Sun being given, to find the Hour of the Day.

Rectifie the Bead as before, then bring the Thread to the Altitude observed, so will the Bead fall upon the Hour of the Day.

EXAMPLE.

As on the first Day of *May* I observed the Sun's Altitude 47 Deg, bring the Thread to 47 Deg. in the Limb, so will the Bead fall on X, or II, so that if the observation was made in the forenoon it was 10 a Clock, if in the Afternoon 2 a Clock.

PROB. III.

The day of the Month being given, to find the Sun's Place in the Ecliptick.

The Thread being laid to the Day of the Month, and where the said Thread crosses the Ecliptick, it shews there the Sun's place without more adoe.

EXAM-

EXAMPLE.

Let the Day given be the 20th Day of *May*, to which Day bring the Thread, so will it fall upon 10 Deg. ♊, in the Ecliptick, the place of the Sun as was required.

PROB. IV.

The place of the Sun being given, to find the Day of the Month.

This is only the Converse of the former, for the Thread being brought to the Sun's place in the Ecliptick, will fall at the same time upon the Day of the Month.

EXAMPLE.

Let the Sun's place given be 10 Deg. ♊, the Thread laid thereon, it doth at the same time fall on the 20th Day of *May*, the thing required.

PROB. V.

The Hour of the Day being given, to find the Sun's Altitude.

Let the Bead be Rectified for the time, and then moved to the Hour of the Day, so doth the String fall on the Altitude of the Sun in the Limb of the Quadrant.

EXAMPLE.

Suppose the 20th Day of *May* (the Bead being Rectified to that time) at 9 of the Clock in the Forenoon, or 3 in the Afternoon, to which Hour bring the Bead, so will the String fall on 44 Deg. in the Limb of the Quadrant, which is the Sun's Altitude at that time, as was required.

PROB. VI.

The Hour of the Night being given, to find how much the Sun is deprest below the Horizon.

Note that the Sun is always as much below the Horizon, at any Hour of the Night as his opposite point is above the Horizon, at the same hour of the Day: Then, the Question being made for any Hour of the Night in Summer-time (the Bead being Rectified for the time) move the String till the Bead fall on the hour amongst the Winter-hours, otherways if it be any hour of the Night in Winter, then move the Bead to the Hour of the Day, amongst the Summer-Hours, so the Degree the thread falleth on in

in the Limb, ſhews how much the Sun is depreſs'd below the Horizon at that time.

EXAMPLE.

Let it be required to know how much the Sun is below the Horizon the 20th day of *May*, at 2 of the Clock in the Morning, or 10 at Night, the Bead being Rectified, and brought to the Hour of 10 and 2, in the Winter-hours; ſo ſhall you find the Thread fall on 12 Deg. 30 Min. in the Limb of the Quadrant, and ſo much is the Sun below the Horizon at that time.

PROB. VII.

The Sun's Depreſſion being given, to find the Hour of the Night with us, or the Hour of the Day to our Antipodes.

Firſt ſet the Bead according to the time; then bring the Thread to the Degree in the Limb of the Quadrant, to the Sun's Depreſſion below the Horizon; ſo will the Bead fall (in the contrary Hour-lines) on the Hour of the Night with us, or hour of the Day to our Antipodes.

EXAMPLE.

The 20th day of *May*, the Sun being in 10 Deg. ♊, and ſuppos'd to be depreſs'd 12 Deg. 30 Min. below the Horizon in the *Eaſt*, and the Bead ſet according to the Day; then bring the String to 12 Deg. 30 Min. in the Limb, the Sun's depreſſion, ſo will the Bead fall (amongſt the Winter-Hours) on the 2 a Clock-line; wherefore to our Antipodes 'tis 2 a Clock in the Afternoon, but to us 'tis 2 a Clock in the Morning.

PROB. VIII.

The Sun's place or Day of the Month being given, to find when the Day breaks, and Twilight ends.

This Propoſition is in Nature and Performance much like the former, for it is taken for granted that the Day is ſaid to begin to break, and Twilight to end, when the Sun is juſt 18 Degrees below the Horizon, wherefore let the Bead be ſet for the time, then bring the Thread to 18 Degrees in the Limb, ſo will the Bead fall on the contrary Hour-lines (as before) and there ſhew the Hour of Twilight.

EXMPLE.

Let it be required to know at what hour in the Morning the Day breaks, or at what time of the Night Twilight ends, on the

20th day of *April*, the Sun being then in 11 Deg. ♉ : First, set the the Bead to the given line, then bring the Thread to 18 Deg. in the Limb, so doth the Bead fall on 20′ before 2 a Clock in the Morning, for the time of the day breaking, or 20′ before 10 at Night Twilight ends.

CHAP. VI.

The Use of the Azimuth-lines.

PROB. I.

The Sun's Altitude being given, to find on what Azimuth he beareth from us.

THE Bead being set for the time, and the Sun's Altitude Observed as is taught in the first Proposition of the second Chapter; Then bring the Thread to the Complement of that Altitude, so will the Bead fall on the Azimuth required.

EXAMPLE.

The 20th Day of *April* (the Bead being set) you observe the Sun's Altitude 31 Deg, remove the Thread to the Complement of that Altitude, *viz.* 59 Deg. or which is all one, to 31 Deg. from the Right-side of the Quadrant, and the Bead will fall on the Azimuth-line 70 Deg. from the Meridian toward the *West*, if the observation was made in the Afternoon, or towards the *East* if the observation was made in the Morning,

PROB. II.

The Azimuth the Sun bears from us being known, to find the Sun's Altitude.

This is but the converse of the former, for (the Bead first set to the time) 'tis but bringing it on to the Azimuth, so will the Thread fall on the Complement of the Sun's Altitude in the Limb, or upon his complete Altitude, by accounting from the Right-side of the Quadrant.

EXAMPLE.

The time given being the 20th Day of *April* (the Bead being set) and the Azimuth given 70 Deg. from the *South*, the Bead being brought there to the String falls on 59 Deg. in the Limb, whose comple-

complement, or distance from the Right-side of the Quadrant, is 31 Deg. the Sun's Altitude required.

The use of the Sun's Azimuth is chiefly necessary for finding a Meridian line, The Coasting of a Country, the Scituation, or Declination of a Building, and Variation of the Compass: But to treat of these severally, would be a digression, as not belonging to the use of the Quadrant.

CHAP. VII.

The use of the Double line of the Sun's Rising and Setting.

PROB. I.

To find the time of the Sun's Rising and Setting.

FIrst, rectifie the Bead to the time, then bring it to the Division in the Double line of the Sun's Rising and Setting, and it there falls upon the Hour and Minute of the Sun's Rising and Setting without further trouble.

EXAMPLE. I.

On the 20th day of *April*, I desire to know the exact time of the Sun's Rising and Setting: The Bead being set to the time, and brought to the time of the Sun's Rising and Setting, it falls on 40 Min. past 4 in the Morning, for the time of his Rising that day, and also on 20 Min. past 7 at Night for the time of his Setting.

EXAMPLE. II.

November the 2d day, the Sun's Rising and Setting is required: First set the Bead to the time, then bring it to the line of the Sun's Rising and Setting, and it there falls on 40 Min. past 7 in the Morning, for the time of his Rising, and on 20 Min. past 4 After Noon, for the time of Sun-Setting.

PROB. II.

To find the length of the Day and Night.

For the length of the Day, 'tis but doubling the *Semi-Nocturnal* Arch, being the Hour and Minute of Sun-Setting and it

gives the length of the Day, and doubling the Sun's *Semi-Diurnal* Arch, or Hour and Minute of Sun-Set, the sum is the length of the Night.

EXAMPLE.

The 20th day of *April*, I desire to know the length of the Day and Night, and first

For the Length of the Day.

	h	'
20th day of *April*, Sun Sets at	7	20
Simi-Nocturnal Arch again	7	20
Length of the Day.	14	40

For the length of the Night.

20th day of *April*, Sun Rises at	4	40
Semi-Diurnal Arch again	4	40
Length of the Night.	9	20

CHAP. VIII.

For finding the Increase and Decrease of the Days.

FIrst, let the Bead be Rectified to the time, and then moved to the line of the Increase and Decrease of the Days, so will the Bead shew how much the Day is either Increased or Decreased, according to the time of the Year.

EXAMPLE. I.

The 20th Day of *April*, I desire to know how much the Day is Increased: First, set the Bead for that time, then bring it to the lines of Increase and Decrease of the Days, so will the Bead fall on 7 Hours 22 Minutes, and so much are the Days Increased.

EXAMPLE II.

On the 2d day of *November*, I desire to know how much the Days are Decreased, first set the Bead for the time, then bring it to the aforesaid line, and the Bead will there fall on 8 Hours, and so much is the day Decreased.

These

These things are so plain and easy that they need no further explanation.

CHAP. IX.

The Use of the Line of Declinations.

PROB. I.

The day of the Month or place of the Sun being given, to find his Declination.

THE String laid upon the day of the Month, or upon the place of the Sun in the Ecliptick, so will the Thread at the same time fall on the Declination of the Sun in the Line of Declinations.

EXAMPLE.

The 20th Day of *May*, I desire to know the Sun's Declination, upon which Day I lay the Thread, or upon 10 Deg. of ♊, the Sun's place at that time, so doth the String at the same time fall on 22 Deg. 2 Min. in the line of Declinations, being the Sun's Declination required.

PROB. II.

The Declination of the Sun being given, to find the day of the Month and place of the Sun in the Ecliptick.

This is the Reverse of the former, for the String laid to the Degree of the Sun's Declination, in the line of Declinations, so will the Thread at the same time fall on the Sun's place in the Ecliptick, and upon the day of the Month in the Circle of Months.

EXAMPLE.

The Sun's Declination given is 22 Deg. 2 Min. upon which in the line of Declinations lay the String, so will the Thread at the same time rest upon 10 Deg. ♊, in the Ecliptick, which is the Sun's place at that time, and also upon the 20th day of *May*, in the Circle of Months.

CHAP.

CHAP. X.

The use of the line of Right Ascensions.

PROB. I.

The place of the Sun or Day of the Month being given, to find the Sun's Right Ascension in Time.

LAY the String upon the Day of the Month, or on the place of the Sun in the Ecliptick, so will it fall (in the line of Right Ascensions) upon the Right Ascension of the Sun in time as was required.

EXAMPLE.

Let it be required to find the Sun's Right Ascension in time on the 30th day of *April* at Noon, at which time the Sun is in 20 Deg. ♉, therefore lay the Thread on the 30th day of *April*, or on the 20 Deg. ♉. at the same time the String falls on (in the line of Right Ascensions) 3 Hours 10 Min. the Sun's R. A. in time, as was required.

☞ Here Note, that 15 Deg. in the Limb, answers to 1 Hour in the line of Right Ascensions, and 30 Deg. to 2 Hours, &c. So that VI Hours in the line of R A. is equal to 90 Deg. in the Limb, being the whole of both Circles and belongs to ♈, ♉, ♊, then are these six Hours, or Divisions Numbred back again by VII, VIII, &c to XII. and the Signs belonging to them are ♋ ♌, ♍; Then beginning again and Number the same Divisions on again, by XIII, XIV, &c. to XVIII, which belongs to ♎, ♏, ♐, and lastly upon the former Divisions Number the Hours back again by XIX, XX, &c. to XXIV hours, which belongs to ♑, ♒, ♓. Hence observe to make use of the proper Number of Hours according to the Signs they belong to.

PROB. II.

Having the place of a Star, to find his R. A. in time.

Lay the Thread to the place of the Star in the Ecliptick, so doth it also at the same time (in the line of R. A.) fall on the Right Ascension of the Star.

EXAMPLE. I.

On the 18th Day of *April*, 1699 at Noon, I find by an *Ephemeris* that ♃ is in 28 Deg. ♐, therefore bring the String to 28 Deg.

28 Deg. ♐, so doth it fall on 17 Hours 51 Min. in the line of R. A. and so much is the R. A. in time, according to his place in the Ecliptick at that time.

EXAMPLE. II.

To find the R. A. of ♀ the 17th day of *April*, 1699, against which Year and Day at Noon, in the *Ephemeris*, I find his place 21 Deg. 30 Min. ♓, to which point in the Ecliptick bring the Thread, and it will also fall (in the Line of R. A.) on 23 hours 27 Min. which is the R. A. in time of *Venus*, as was required.

EXAMPLE. III.

To find the R A. in time of ♂ the 25th day of *February*, 1701, at which time by an *Ephemeris* I find ♂ in 24 Deg. ♈; the Thread brought to that point in the Ecliptick, it doth at the same time fall on 1 Hour 29 Min. the thing demanded.

EXAMPLE. IV.

To find the R A. of ☿ the 16th day of *July*, 1701, at Noon, at which time by an *Ephemeris*, I find him in 0 Deg. ♍, therefore laying the Thread upon that point in the Ecliptick, it will at the same time fall on 10 Hours 8 Min. for the R. A. of ☿ in time, the thing Sought.

These few Examples are sufficient to explain the whole Nature of this line of R. A. which hereafter we shall apply to the finding the Southing of the Planets and fixed Stars. This line is exact in the Numbering of Hours, and way of working tho' not admitting of equal divisions. And Note what is said against this may be understood of the Lines of Oblique Ascensions and Descensions, whose use is treated of in the following Chapter.

CHAP. XI.

The Use of the Lines of Oblique Ascensions and Descensions.

PROB. I.

The Sun's place being given, to find his Oblique Ascension or Oblique Descension.

BRing the Thread to the place of the Sun in the Ecliptick, so doth it fall on the Oblique Ascension of the Sun in the line of Oblique Ascensions.

EXAM-

EXAMPLE.

On the 30th day of *April* at Noon, I find the Sun to be in 20 Deg. ♉, to which point in the Ecliptick bring the Thread, and you will at the same time find it fall (in the line of O. A.) on 1 Hour 34 Min. the O. A. of the Sun as was required.

For the Oblique Descension.

Lay the Thread to the opposite point of the Sun's place in the Ecliptick, and the Thread will fall on the Oblique Descension in the line thereof.

EXAMPLE.

Let the Oblique Descension at the time of the last example be required, to find which bring the Thread to 20 Deg. ♏, which is the opposite point, so will the Thread fall on (in the line of O. D.) 16 Hours 48 Min. which is the O. D. of the Sun at that time.

PROB. II.

Having the Longitude and Latitude of a Planet or fixed Star, to find their Oblique Ascension or Descension.

The only difference between this and the last Proposition, is in respect of the Obliquity of the Ecliptick, for the Sun being always therein cannot be subject to Latitude, because Latitude is always accounted from the Ecliptick, but the Planets deviate more or less from it, according to their position, and the fixed are placed in several Latitudes, without being Subject to Variation tho' they have a Motion in Longitude according to the Progression of the Equinox.

Now to find the Oblique Ascension of a Planet or Star with Latitude, you are first to proceed as you are taught in the last proposition, by bringing the Thread to the place of the Star in the Ecliptick, so will it fall on the line of Oblique Ascensions, upon the Hour and Minute of the O. A. of the Star, which Note down, then observe this

RULE.

Rule, If the Star have *South*-Latitude, for every Degree thereof add 6 Min. to the O. A. before set down, but if *North*-Latitude then Substract 6 Min. from the O. A. before found, so will the Sum or difference be the true O A. required, and by this equation of adding or Substracting of 6 Min. for every degree of Latitude, you shall have the O. A. at any time, without sensible errour.

EXAM-

EXAMPLE. I.

The 1st. day of *November*, 1700, I find the Planet *Saturn* in 7 Deg. ♓, with 2 Deg. of *South* Latitude, lay the Thread in the Ecliptick line to 7 Deg. ♓, and the String will fall in the line of O. A. on 23 Hours 22 Min. now because *Saturn* hath 2 Deg. of *South* Latitude, I must add 12 Min. to 23 Hours 34 Min. the O. A. of ♄ for that time, with respect to his Longitude and Latitude.

EXAMPLE. II.

Upon the 15th day of *November*, 1700. I find *Venus* in 18 Deg. ♎, with 2 Deg. *North* Latitude; then, as before, bring the String to 18 Deg. ♎, in the Ecliptick, and it falls on 13 Hours 43 Min. in the line of O. A. and because ♀ hath 2 Deg. of *North* Latitude, I Substract 12 Min. from the 13 hours 43 Min, and the remainder is 13 Hours 31 Min. for the O. A. of *Venus*.

PROB. III.

For the Oblique Descension with Latitude

To find the Oblique Descension with Latitude, lay the Thread in the Ecliptick to the opposite Sign and Degree of the Planet or Star's place, so will the Thread fall on the O. D. in the line thereof, and by adding or Substracting for every Degree of Latitude, (according to the Rule) 6 Min. by taking the Latitude of a contrary Denomination, so will the true Oblique Descension appear.

EXAMPLE.

Let it be required to find the O. D. of *Saturn*, the 1st day of *November*, 1700, at which time his place in Longitude is 7 Deg. ♓, with 2 Deg. *South* Latitude: Lay the Thread in the Ecliptick to 7 Deg. ♍, the opposite Sign and Degree, so doth the line fall on 9 Hours 47 Min. from which Substract 12 Min. because I am to make use of the Latitude of a Contrary Denomination *viz. North*, according to the Rule, and there remains 9 Hours, 35 Min. the O. D. of ♄ as was required.

CHAP. XII.

To find the true time of any Planet or fixed Star's coming to the South.

TO the estimate time, find the Right Ascension of the Planet, or Star, as before is taught in the Xth Chap. and the Sun's R. A. for the same time, then Substract the R. A. of the Sun, from the R. A. of the Star, or Planet (the Star's R. A. being Increased by 24 Hours, if need require) the Remainder is the true time of the Planet or Star's coming to the *South.*

EXAMPLE. I.

To know the true time of *Mars*'s coming to the *South* the 1st day of *July*, 1700, which by his distance from the Sun, I guess may be about 7 at Night, *Mars* at that time is in 13 Deg. ♏, the String being brought to that Point in the Ecliptick, shews his R. A. (in the line of Right Ascensions) to be 14 Hours 42. Min. the Sun at the same time is in 20 Deg. ♋, whose R. A. (as before directed) is found 7 hours 27 Min. which taken from 14 hours, 42 Min. the R. A. of *Mars*, leaveth 7 Hours 15 Min. for the time of ♂ coming to the *South* that Night.

EXAMPLE. II.

To find the true time of *Venus*'s coming to the *South*, the 1st day of *November*, 1700, at the estimate time thereof, *Venus* is in 3 Deg. ♎, and the Sun in 20 Deg. ♏, the R. A. of *Venus* by the Quadrant is found 12 Hours 10 Min. and the R. A. of the Sun 15 Hours 10 Min. Now because the Sun's R. A. is greater than the R. A. of *Venus*, I add 24 Hours to the R. A. of *Venus*, which makes the Sum 36 Hours. 10 Min. from which take the Sun's R. A. 15 Hours 10 Min. and the Remainder is 21 Hours 0 Min. from which taking 12 Hours, there remains 9 Hours 0 Min. in the Morning, for the time of *Venus* coming to the *South*.

EXAMPLE. III.

The time of *Aldebaran*'s coming to the *South* is required *November* the 1st day, 1700, whose Longitude is 5 Deg. 40 Min. ♊, and the Sun in 20 Deg. 30 Min. ♏, the R. A. of *Aldebaran* is found by the Quadrant 4 Hours 15 Min. and the Right Ascension of the Sun 15 Hours 12 Min. Now because 24 Hours must first be added to 4 Hours 15 Min. by reason Substraction cannot be made, It makes the Sum 28 Hours 15 Min. from which Substract 15 Hours 12 Min. the Sun's R. A. the remainder

is

is 13 Hours 3 Min. or 3' paſt 1, in the Morning, for the true time of *Aldebaran's* coming to the *South.*

CHAP. XIII.

To find the time of the Planets and fixed Stars Riſing and Setting.

FIND the Oblique Aſcenſion of the Planet or Star with Latitude, as is taught in the 11th Chapter, for the time given, and alſo the Oblique Aſcenſion of the Sun for the ſame time: Then Subſtracting the O. A. of the Sun, from the O. A. of the Star or Planet, and to the remainder add the time of the Sun's Riſing, and if the Sum exceed 24 Hours, take 24 Hours from it; ſo is the Sum or difference the true time of the Planet or Star's Riſing.

EXAMPLE. I. *Of the Riſing.*

Let it be required to find the true time of *Jupiter's* Riſing, the 1ſt. day of *February*, 1700, at which time he is in 19 Deg. 30 Min. ♈ with no Latitude, the Sun at the eſtimate time of the Star's Riſing is in 23 Deg. 30 Min. ♒; then find the O. A. by the Quadrant as is directed in the XIth Chap. and place them down as here.

	h	'
O. A. of ♃, by the Quadrant is	21	34
to which add	24	00
O. A. of ♃ Increaſed by 24 Hours is	45	34
O. A. of the Sun Subſtract	22	59
Remains.	22	35
Time of Sun-Riſing add	7	10
Sum.	29	45
24 Hours Subſtract	24	00
Hence the time of ♃'s Riſing is at	5	45
That is 45' paſt 5 in the Morning		

EXAMPLE. II. *of the Riſing.*

The 10th day of *March*, 1700, I deſire to know what time the *Virgin's Spick* riſes, at which time he is in 90 Deg. 40 Min. ♎, with

with 2 Deg. *South*-Latitude, the Sun at the estimate time of the Star's Rising is in 1 Deg. 20 Min. ♈; then find by the Quadrant the O. A. of the *Virgin's Spick* with Latitude, as in the 2d Prob. of the XIth Chapter, and the Sun's O. A. also, then by Substracting the O. A. of the Sun, from the O. A. of the Star, and to the difference or remainder, add the time of the Sun's Rising, to which Sum, Add 12 Min. for the 2 Deg. of *South*-Latitude, according to the Rule, and the Remainder is the true time of the *Virgin's Spick*'s Rising that Night.

The Operation.

	h	'
O. A. of the *Virgin's Spick*	13	54
O. A. of the Sun Substract	0	02
Remainder	13	52
The time of Sun-Rising add	6	00
Sum	19	52
Because it exceeds 12 Hours Substract	12	00
Remains	7	52
According to the Rule add	0	12
Hence the *V. Spick* Rises that Night at	8	04

That is 4 Min. past 8 at Night.

For the Setting of the Stars

Find the Oblique Descension of the Planet or Fixed Star, with Latitude (if it have any) as is taught in the 3d Prob. of the XIth Chap. and likewise the Oblique Descension of the Sun, then Substract the O. D. of the Sun, from the O. D. of the Star, and to the remainder add the time of Sun-setting, then to, or from that sum, add or Substract for the Latitude (if the Star have any) according to the Rule, so will the Sum or Remainder be the true time of the Star's Setting

EXAMPLE. I. *Of the Setting.*

Let it be required to find what time of the Night *Venus* sets the 1st. day of *March*, 1700; *Venus*'s place at the estimate time of Rising is 20 Deg. 20 Min. ♈ with no Latitude, the Sun's place at that time 22 Deg. 30 Min. ♓.

Hence

	h	'
Hence the		
O. D. of *Venus* is	13	56
O. D. of the *Sun* is	11	17
difference	2	39
Time of Sun-Setting add	5	42
Venus Sets that Night at	8	21

That is 21 Min. past 8 at Night.

EXAMPLE. II. *Of the Setting.*

Let it be required by the Quadrant, what Hour of the Night the *Pleiades* Sets the 14th day of *March*, 1700, at which time the Seven Stars are in 25 Deg. 48 Min. ♉, with 4 Deg. *North*-Latitude; the Sun's place at the Estimate time is 5 Deg. 30 Min. ♈, then find the O. D. of the *Pleiades*, as in the 3d Prob. of the XIth Chapter, and the Sun's O. D. also for the same time, &c.

See the Work.

	h	'
O. D. of the *Pleiades* is	17	23
O. D of the *Sun* Substract	12	33
Remainder	4	50
Time of Sun-Setting add	6	09
Sum	10	59
For the Lat. (according to the Rule) add	00	24
Hence the Seven Stars Set that Night at	11	23

That is 23 Min. past 11 at Night.

Here Note, that I have apply'd the Minutes respecting the Latitude to the last Sum, which according to the Rule should have been apply'd to the O. A. or O. D. of the Star: But as it makes no alteration in the Work, each Person is at his Liberty to apply it to which place he pleases.

CHAP.

CHAP. XIV.

The Description of the Lines on the back-side of the Quadrant.

I. THE several Circular lines, as they are divided, make a complete Table of Houses for the Latitude of 52 Deg. The bottom Circle is divided into 24 equal parts, or hours, being the line Intituled, Time from Noon. The next above it, is the line of the Xth House; the next above that, the Line or Table of the XIth House, the next is the XIIth, the next, the Ascend. The next above the Ascend. is the IId; and the uppermost is the line of the IIId, and are Projected into the Quadrant from a Table of Houses for the Latitude of 52 Degrees.

II. On either side of the Quadrant, betwixt the Circular lines of Houses and the Centre, is placed 4 lines, *viz.* 2 on the Right-side, and 2 on the Left-side, *viz.* First, a line of Diameters, and Secondly, a line of Circumferences, agreeing thereto; On the Right-side is, First a line of Areas, shewing the Area or Superficial Content of a Circle, agreeing to the former lines of Diameters and Circumferences; and Secondly, a line of Square-Roots, shewing the true Square any Circle will bear according to the Diameter, and Circumference, and Area thereof, which shews the Square equal of any Cylindrical Solid, agreeing to the Diameter, Circumference, and Area of the Circle upon the lines before described.

III. In the middle (to supply a Vacant place) I have Inserted An *Almanack* shewing the Year of our Lord, the Day of the Month, Dominical Letter, &c.

CHAP. XV.

The Use of the Table of Houses.

TO Erect a Figure of the Heavens for any time of the Day, it must first be understood, that *Astronomers* account their day from Noon to Noon, each *Astronomical* Day consisting of 24 Hours, so that 1 Hour after Noon is accounted the first hour of the Day, and 11 a Clock, or 1 hour before Noon, is accounted 23 hours from Noon, this being understood.

First, get the time of the Day you Intend to erect your Figure for, or time from Noon, for which time by the Quadrant (by an *Ephemeris*, or by calculation) find the Sign and Degree of

of the Sun's place: Then repair to the Quadrant, and in the line of the Xth House find the aforesaid Sign and Degree of the Sun's place, upon which lay the String: Then observe what Hour and Minute the String at that time falls in the bottom-line, or line of Time from Noon, to which add the time after Noon; upon which Number or Sum lay the Thread, in the line of Time from Noon, So will the Thread fall on the Cusps of the Six Oriental Houses, which place down in your Scheme, observing that their opposite Houses have opposite Signs and Degrees.

EXAMPLE.

Let it be required to know how the Heavens are posited the 15th day of *March*, 1700. at 1 of the Clock in the afternoon, at which time (according to the 3d Prob. of the Vth Chapter) I find the Sun to be in 6 Deg. ♈, to which bring the Thread in the line of the Xth House, so will it fall at the same time on 0 Hour 22 Min. in the line of Time from Noon, to which add 1 Hour, your Time from Noon, and the Sum is 1 Hour 22 Min. upon which, in the line of Time from Noon, lay the Thread, and it then falls upon the Six Oriental Houses as followeth.

Six Oriental Houses.				Opposite Houses have Opposite Signs and Deg.	Six Occidental Houses.			
X.	22°	00′	♈		IV.	22°	00′	♎
XI.	7	00	♊		V.	7	00	♐
XII.	16	00	♋		VI.	16	00	♑
I.	11	29	♌		VII.	11	29	♒
II.	1	00	♍		VIII.	1	00	♓
III.	22	00	♍		IX.	22	00	♓

Which place into your Scheme in this following order.

Now

Now the Planets places by the *Ephemeris*, at the same time, are thus.

♄	7°	56′	♋ s
♃	27	15	♑
♂	25	11	♏
☉	6	00	♈

♀	6°	57′	♉ s
☿	4	00	♈
☽	16	24	♊
☊	12	45	♍

The ☋ is always opposite to ☊.

Now for the right placing of the Planets into the Scheme, observe this Rule, *viz.* If the Planet's place be less than the Cusp of the House, he is to be placed in; Then place him before the Cusp thereof, but if his Degrees be more than the Cusp of the House, then place him behind, as in the aforegoing Scheme.

Note, that when the Hour answering the Sun's place in the Xth House, and Hours, or time after noon added, make more than 24 Hours, then Substract 24 hours, and the remainder is the number to be made use of.

CHAP. XVI.

The Use of the Lines of Diameters, Circumferences, Areas, and Square-Roots.

PROB. I.

By having the Diameter of a Circle, to find the Circumference.

FInd the Diameter upon the line of Diameters, marked with the Letter D. against which on the line C. is the Circumference answering the given Diameter.

EXAMPLE.

Suppose the Diameter be 28, which find in the line of Diameters, and against it in the line of Circumferences Stands 88.0 for the Circumference.

PROB.

PROB. II.

By having the Circumference, to find the Diameter.

EXAMPLE.

Let us ſuppoſe the Circumference to be 88.o, which find in in the line of Circumferences, and againſt it in the line of Diameters ſtands, 28.o, for the Diameter, Anſwering to that Circumference.

And here let it be obſerved, that when either the Diameter or Circumference is given, the other anſwers thereto in the line thereof, and likewiſe doth the Circles of Areas, and Square-Roots, anſwer the Circles of the ſame Diameters and Circumferences, but becauſe theſe two lines of Areas and Square-Roots, doe not joyn to the lines of Diameters and Circumferences, 'tis but moving the Bead upon the String to the Diameter or Circumference given, and then carrying it over to the lines of Areas, and Square-Roots, where the ſaid Bead falls on both the Area, in the line of Areas, and Square-Root, in the line of Square-Roots, agreeing to both the Diameter and Circumference, the Bead was ſet to.

PROB. III.

To find the Area of a Circle.

The Diameter or Circumference of a Circle, or both being given, to find the Area of the Circle Correſponding, 'tis but moving the Bead to the given Diameter or Circumference in their reſpective lines; Then transfer the Bead to the Scale of Areas of Circles, marked with A, ſo doth the Bead there fall on the Area, or Superficial content of that Circle, agreeing to the ſaid Diameter and Circumference.

EXAMPLE.

Suppoſe the Diameter given 28.o, or Circumference 88.o, to which fix the Bead, in their reſpective lines; which done, transfer it to the line of Areas, and there it falls upon 616.oo, for the Area, or Superficial content of that Circle.

PROB. IV.

The Uſe of the Line of Square-Roots.

By having the Area of a Circle, to find the Square equal, or true Square that Circle will bear.

EXAMPLE.

Admit the Area of a Circle to be 400, which find in the line of Areas, againſt which in the line of Squares, marked with S, ſtands, 20.0, for the true Square that Circle will bear.

PROB. V.

By having the Diameter, or Circumference of any Circle, to find what Square that Circle will bear.

EXAMPLE.

Suppoſe the Circumference of a Circle or Timber-Stick be 120.0, and its Diameter 38.2, to which, place the Bead in the reſpective line, or lines, then carry it over the line of Squares, and it there falls upon 33.85, for the true Square of ſuch Circle or Timber-Stick.

Note, that the Thread that ſupplys the Foreſide, coming thro' the Centre, may be extended to the Limb on the Backſide, having a Bead put upon it, as the other ſide hath, but no Plummet.

CHAP. XVII.

The Explanation and Uſe of the ALMANACK.

I. UNder the Title *Years*, is placed as many Years as the Table will bear, *viz.* from 1697, to 1758, in all 62 Years, on the top of which is plac'd the Seaven Dominical Letters, which are fitted to the Years underneath them.

II. Under the Title *Sundays*, is firſt placed Figures gradually from 1 to 31, repreſenting the ſeveral Sundays in each Month and Year, ſhewing what day of the Month each Sunday in any Month and Year will fall upon.

III. The Capital Letters placed in the Squares below, are Dominical Letters fitted to thoſe Years, and Serve to direct to the day of the Month.

IV. The Months of the Year are placed againſt the Dominical Letters, for further Directions to what follows.

PROB.

PROB. I.

The Year of our Lord being given, to find the day of the Month.

I. First, find the Year you desire under the Title *Years*, and in the top of the same Column stands the Dominical Letter, answering to that Year.

II. Secondly, Seek the Month you desire against the Letter before found, over which in the same Column stands all the Sundays in that Month.

EXAMPLE. I.

Suppose it be required to find what day of the Month is the first Monday in *May*, 1700.

Find 1700 under the Title *Years*, and over it you will find F, then amongst the Months find *May*, from thence direct your Eye to F, in the same line, and over it you have all the Sundays in that Month, *viz.* the 5, 12, 19, and 26th day of *May*, are all the Sundays in that Month, so that Monday is the 6th day.

EXAMPLE. II.

Let it be required to know what day of the Month is the first Monday in *July*, 1715.

First, over the Year is found B, then against *July* over B, is found 3, 10, 17, 24, 31, that is the 3d day of *July*, is the first Sunday in that Month, for that Year, the 10th day is the Second Sunday &c. so that the first Monday in *July*, 1715, is the 4th day.

PROB. II.

Let it be required to know what day of the Week, any fixed Feast falls on.

This is in effect the same with the former, as we shall hereafter prove.

EXAMPLE.

Let it be required to know what day of the Week St. *James* falls on, 1700, it being always the 25th day of *July*.

I. Over the Year is found F. under the Title *Years*.

II. Under the Title *Sundays* against the Month *July*, and over F stands these Numbers. 7, 14, 21, 28, being the days of the Month the Sundays happen; then observing the third Sunday is the 21st, by counting on, Thursday is found the 25th day, for the day of the Week St. *James* this Year falls on.

PROB. III.

The Year of our Lord being known, to find what day of the Week is any day of the Month.

This is nothing but the Converse of the former, though altogether as useful.

EXAMPLE.

Let it be required to know what day of the Week is the 3d day of *July*, 1700, over which Year you will find F, then against *July* and over F, you'l find the first Sunday to be the 7th day, hence by counting backwards, Saturday 6, Friday 5, Thursday, 4, Wednesday 3.

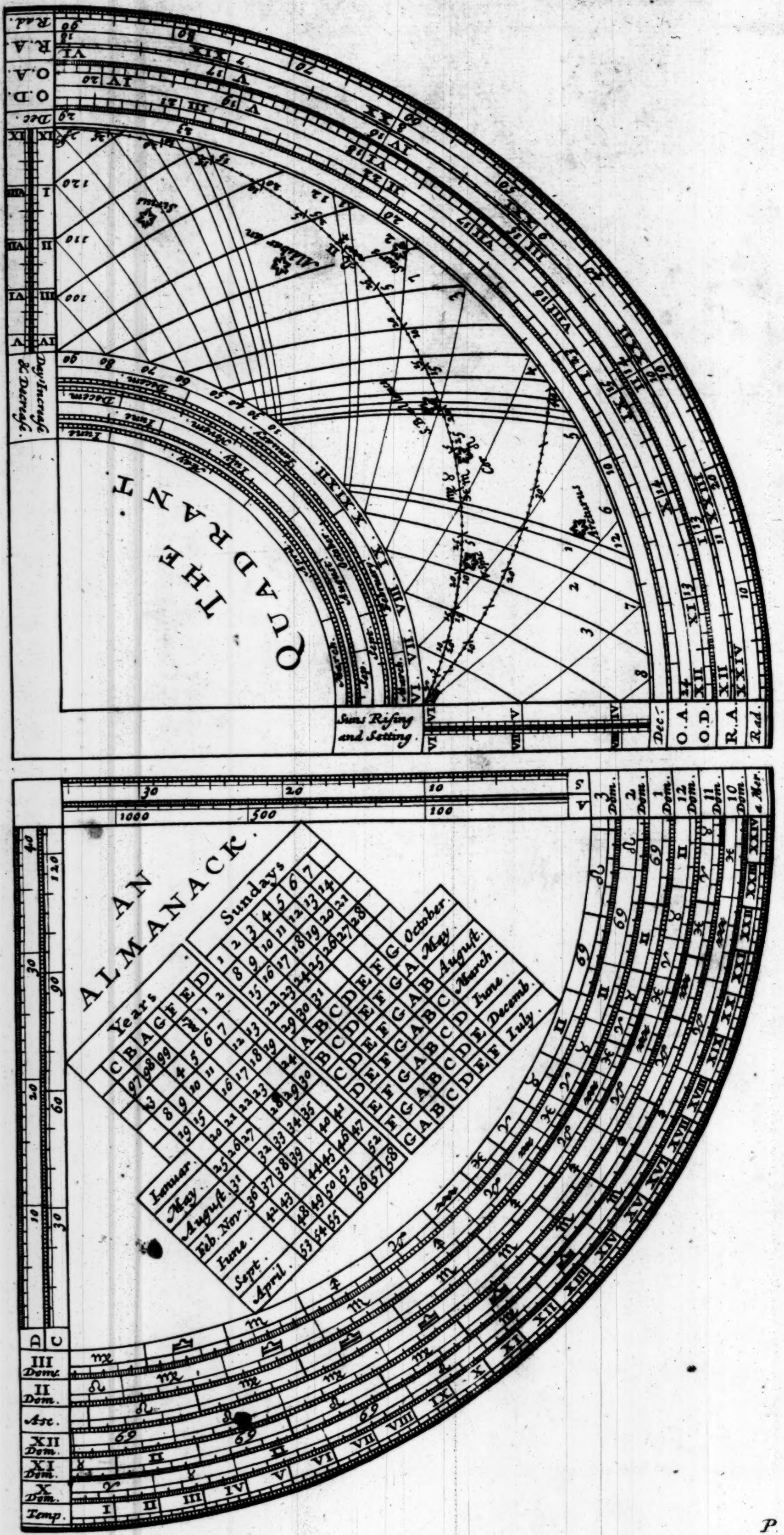
PROB. IV.

The Year of our Lord being given, to find the Dominical Letter for that Year.

Let it be required to know what the Dominical Letter is for the Year of our Lord 1701; seek the Year under the Title *Years* and over it is E the Dominical Letter for that Year.

Here follows the Figure of the Quadrant, Adjusted to the Latitude of 52 Deg.

Tabula



P. 316.

Tabula Refractionum.

Dist. à Vert.	Refract.		Dist. à Vert.	Refract.		Dist. à Vert.	Refract.	
D.	′	″	D.	′	″	D.	′	″
1	0	1	31	0	30	61	1	27
2	0	2	32	0	31	62	1	31
3	0	2	33	0	32	63	1	36
4	0	3	34	0	33	64	1	40
5	0	4	35	0	34	65	1	45
6	0	5	36	0	35	66	1	50
7	0	6	37	0	36	67	1	55
8	0	6	38	0	37	68	2	1
9	0	7	39	0	39	69	2	7
10	0	8	40	0	41	70	2	14
11	0	9	41	0	42	71	2	22
12	0	10	42	0	44	72	2	31
13	0	11	43	0	46	73	2	40
14	0	12	44	0	47	74	2	50
15	0	13	45	0	49	75	3	3
16	0	14	46	0	51	76	3	16
17	0	15	47	0	53	77	3	32
18	0	16	48	0	55	78	3	48
19	0	17	49	0	57	79	4	9
20	0	18	50	0	59	80	4	35
21	0	19	51	1	0	81	5	5
22	0	20	52	1	2	82	5	42
23	0	21	53	1	5	83	6	30
24	0	22	54	1	8	84	7	32
25	0	23	55	1	10	85	8	55
26	0	24	56	1	12	86	10	53
27	0	26	57	1	15	87	13	55
28	0	27	58	1	18	88	18	24
29	0	28	59	1	21	89	25	12
30	0	29	60	1	24	90	30	0

A Table

A Table of Æquation of time, shewing what a Pendulum-Clock or Watch ought to differ from a Sun-Dial.

	Jan.		*Feb.*		*Mar.*		*April.*		*May.*		*June.*	
D.	M.	S.	M.	S.	M.	S.	M.	S.	M.	S.	M.	S.
1	9	0	14	49	10	8	0	49	4	9	1	5
2	9	22	14	48	9	51	0	32	4	11	0	53
3	9 Pendulum.	44	14 gains.	46	9 gains.	34	0 gains.	16	4 loses.	12	0 loses.	40
4	10	6	14	43	9	17	0	1	4	13	0	28
5	10	27	14	39	8	59	0	14	4	12	0	16
6	10	46	14	34	8	42	0	29	4	11	0	3
7	11	5	14	29	8	24	0	44	4	10	0	10
8	11 Gains.	24	14 gains.	24	8 gains.	5	0 * Loses.	58	4 loses.	8	0 * Gains.	23
9	11	41	14	17	7	47	1	12	4	6	0	36
10	11	58	14	10	7	29	1	26	4	4	0	49
11	12	15	14	2	7	10	1	38	4	1	1	1
12	12	31	13	53	6	52	1	51	3	57	1	14
13	12 gains.	45	13 gains.	44	6 gains.	33	2 loses.	3	3 loses.	52	1 gains.	27
14	12	59	13	35	6	15	2	14	3	47	1	40
15	13	13	13	24	5	56	2	24	3	41	1	53
16	13	25	13	13	5	37	2	35	3	35	2	5
17	13	35	13	2	5	18	2	46	3	29	2	17
18	13 gains.	46	12 gains.	50	5 gains.	0	2 loses.	56	3 loses.	23	2 gains.	29
19	13	57	12	37	4	41	3	4	3	15	2	41
20	14	6	12	25	4	22	3	12	3	7	2	53
21	14	14	12	12	4	3	3	20	2	58	3	4
22	14	21	11	57	3	44	3	28	2	50	3	16
23	14 gains.	28	11 gains.	43	3 gains.	26	3 loses.	35	2 loses.	41	3 gains.	27
24	14	33	11	28	3	8	3	42	2	31	3	38
25	14	38	11	13	2	49	3	47	2	21	3	48
26	14	42	10	58	2	31	3	52	2	11	3	59
27	14	45	10	42	2	13	3	56	2	1	4	9
28	14 gains.	48	10 gains.	25	1 gains.	55	4 loses.	0	1 loses.	51	4 gains.	18
29	14	49			1	38	4	3	1	40	4	27
30	14	50			1	22	4	6	1	28	4	35
31	14	50			1	5			1	17		

A Table

A Table of Æquation of Time, shewing what a Pendulum-Clock or Watch ought to differ from a Sun-Dial.

	July.		Aug.		Sep.		Octob.		Nov.		Dec.	
D.	M.	S.	M.	S.	M.	S.	M.	S.	M.	S.	M.	S.
1	4	43	4	30	3	48	13	14	15	23	5	42
2	4	51	4	20	4	9	13	28	15	15	5	13
3	4 gains.	58	4 gains.	10	4 loses.	29	13 loses.	42	15 loses.	5	4 loses.	45
4	5	5	4	0	4	50	13	56	14	53	4	16
5	5	11	3	49	5	10	14	8	14	45	3	47
6	5	17	3	37	5	31	14	20	14	33	3	17
7	5	23	3	24	5	51	14	31	14	29	2	47
8	5 gains.	28	3 gains.	11	6 loses.	12	14 loses.	41	14 loses.	6	2 loses.	17
9	5	32	2	58	6	33	14	51	13	52	1	48
10	5	35	2	44	6	53	15	1	13	38	1	18
11	5	38	2	30	7	14	15	11	13	21	0	* 48
12	5	41	2	16	7	34	15	20	13	4	0	18
13	5 gains.	43	2 gains.	2	7 loses.	54	15 loses.	26	12 loses.	47	0 Gains.	12
14	5	45	1	46	8	14	15	32	12	28	0	42
15	5	46	1	30	8	33	15	38	12	9	1	12
16	5	46	1	13	8	53	15	44	11	50	1	41
17	5	45	0	56	9	13	15	49	11	30	2	10
18	5 gains.	44	0 gains.	39	9 loses.	32	15 loses.	52	11 loses.	9	2 gains.	39
19	5	42	0	21	9	52	15	55	10	47	3	08
20	5	40	0	3	10	11	15	56	10	25	3	37
21	5	38	0	* 14	10	30	15	58	10	2	4	05
22	5	35	0	31	10	48	15	59	9	38	4	32
23	5 gains.	31	0 Loses.	50	11 loses.	6	16 loses.	0	9 loses.	14	5 gains.	00
24	5	27	1	9	11	24	15	59	8	49	5	27
25	5	22	1	29	11	41	15	57	8	23	5	55
26	5	16	1	49	11	58	15	55	7	57	6	21
27	5	10	2	7	12	14	15	52	7	31	6	48
28	5 gains.	3	2 loses.	27	12 loses.	29	15 loses.	48	7 loses.	5	7 gains.	14
29	4	56	2	47	12	45	15	43	6	38	7	39
30	4	48	3	8	13	0	15	37	6	10	8	4
31	4	39	3	28			15	31			8	27

The

☞ *The Table of* Refractions *I had from that unparallel'd Artist* Mr. John Flamsted, *by whose Observations (in a little time) we hope to see Astronomy more gloriously array'd.*

The Use of the Table of Refractions.

This Table is to be enter'd with the distance of the *Sun*, *Moon*, or *Stars*, from the *Vertex*, or *Zenith*, which is no more than the Complement of the Altitude to 90 Degrees.

EXAMPLE.

Suppose the Altitude of the Sun by Observation be 28 Deg. as *page* 289. its complement to 90 is 62 Deg. which is the distance from the *Vertex*, with which, enter the Table of Refractions, under the Title *Dist. à Vert.* Against which and under the Title *Refract.* is 1′ 31″ the Refraction Required, which taken from 28 Deg. the observed Altitude, there remains 27° 58′ 29″ for the correct Altitude of the Sun at the time of Observation.

The End of the Sixth BOOK.

THE ART OF SURVEYING, BOOK VII.

In Three PARTS.

CONTAINING,

I. Several Problemes in Geography, and Spherical Trigonometry.

II. Aſtronomical Problemes.

III. A Practical Tract of the Art of Dialling.

Formerly Publiſh'd by

M^r *VINCENT WING*;

Now much Augmented and Enlarg'd by his NEPHEW,

JOHN WING, Math.

Whereunto are Added by the ſame Hand,

TABLES of Right and Oblique Aſcenſions in Time, to five Degrees of North and South-Latitude.

LONDON,

Printed, for *Awnſham* and *John Churchill*, at the *Black Swan* in *Pater-Noſter-Row*, MDCXCIX.

THE Art of Surveying.

BOOK VII.

PART. I.

INTRODUCTION.

ALthough we have not hitherto treated of Sphærical Triangles (as being of little or no Uſe in the former parts of this Book) yet becauſe the diſtance of Places upon the Terreſtial Globe, cannot preciſely be Surveyed and determined without ſome knowledge therein, we ſhall here lay down ſome compendious Problems performed thereby, which no doubt will be very requiſite and neceſſary for my Surveyor to make uſe of: For by the help and aſſiſtance thereof, He may both ſpeedily and exactly, find the diſtance of any Cities and Places ſituate upon the Superficies of the Earth, as they are to be rekoned in a Sphærical line, which I have here added, in regard that in the former Books I have already ſhewed how the diſtance of any Places that lye under the Eye, may be diſcover'd, and truly found out by the ſolution of Right-lined Triangles; ſo that now there is not a place either near, or far remote, but (if the Longitude and Latitude be truly known) its bearing and diſtance may alſo be known and computed (and that with much celerity and exactneſs) as we ſhall demonſtrate in the enſuing Problems, which no doubt will yield abundance of delight and recreation to all, though more eſpecially to ſuch, as have not yet taſted of things of this nature, wherein I ſhall in as plain a Method as may be, (though with ſome brevity) deliver what I intend upon this Subject, and refer ſuch as are more curious, and delight in varieties, to my *Aſtronomia Britannica.* But firſt it will not be unfit, to ſhew what the Longitude and Latitude of a place is, and how the diſtance of one place from another, is repreſented to the Eye, according to the projection of the Sphere.

I. The Longitude of a place is the distance thereof from the Fortunate Islands beyond *Portugal*, which is called the Primary Meridian, from whence the Longitude of all places upon the Earth, are numbered in the Equinoctial, towards the *East*.

II. The Latitude of a place is the distance thereof, from the Equinoctial Circle, which is numbered in the Meridian, towards one of the Poles.

III. The distance of two places is an Arch of a great Circle, passing through both the said places, and is the shortest space between them, upon the Earth's superficies.

Although the Longitude of a place may be had, and found out several ways, yet the most exact of all other is by the Moon's Eclipse. As suppose the Moon's Eclipse should begin at *London*, at 8 a Clock and 55 Min. at Night, and the same Evening it is observed to begin at *Rome*, at 9 a Clock and 46 Min. the difference will be 51 Min. or 12 Deg. and 45 Min. which added to the Longitude of *London* 24 Deg. 20 Min. pointeth out the Longitude of *Rome*, 37 Deg. and 5 Min.

The Latitude of a place may be taken any Day in the Year, by the height of the Sun at Noon, and by the help of his Declination; for if the Sun have *South* Declination, add to the same his Altitude observed by a Quadrant, being corrected by Parallax and Refraction; or if he have *North* Declination, Substract the same from his Altitude observed, and you shall have the complement of the Elevation of the Pole.

EXAMPLE.

The 10th Day of *April* 1661, the Sun at Noon, (according to my *Ephemerides*) was in 0 Degrees. 52 Minutes. *Taurus*, having *North* Declination 11 Deg. and 49 Min. at which time, his true Meridian Altitude was observed here at *Luffenham* to be 49 Deg. and 9 Min. therefore, according to the Rule, because he hath *North* Declination, I Substract the Declination out of the Altitude, and there remains 37 Deg. 20 Min. which is the complement of the Pole's Elevation.

But because there are already extant, particular Catalogues of the Longitude and Latitude of most Cities and places in the World, we shall not further insist upon this Business, but shall in the following Problems, shew how to investigate exactly the itinerary distance of any two places, upon the Globe of the Earth.

PROB. I.

Two Places differing only in Longitude, to find their Distance.

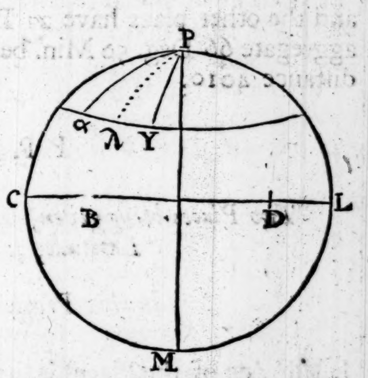
FOR Explanation, observe that in the adjunct Diagram, the outermost Circle marked with the Letters P C M L, represents the primary Meridian of the Earth, C D B L, the Earth's Equinoctial, P the *North* Pole thereof, M the *South* Pole &c.

In

In this Problem are two Cases.

I. If both the places are under the Equinoctial, then the difference of their Longitude is the distance required.

EXAMPE.



Suppose B to be the Island of St. *Thomas*, which hath Longitude 33 Degrees. and 10 Minutes. and D the Island of *Sumatra*, whose Longitude is 137 Deg. 10 Min. therefore the difference of their Longitude 104 Deg. converted into English Miles, by allowing 60 to one Deg. giveth 6240 for their distance.

II. If the two Places given are not situate under the Equinoctial, but lie under some parallel between the Equinoctial and one of the Poles, then take this Example.

In this Diagram, let α represent the City of *Compostella* in *Spain*, whose Latitude is 43 Deg. and *y* the City of *Constantinople*, which hath the same Latitude, but differs in Longitude 44 Deg. wherefore to find their distance α *y*, take the half difference of their Longitude α λ, or λ *y* 22 Deg. Then, in the Rectangled Triangle α λ P, we have known (1.) α P, the Complement of the Pole's Elevation, 47 Deg. (2.) the Angle α P λ, the half difference of the Longitude of the said Cities, 22 Deg. (3.) P λ α, a right Angle 90 Deg. hence to find α λ, I say,

As the Radius 90 Deg.	10.00000
To the the sine of the Angle α P λ, 22 Deg.	9.57357
So the sine of P α, 47 Deg.	9.86413
To the sine of α λ, 15 Deg. 54 Min.	9.43770

Which doubled giveth their distance 31 Deg. 48 Min. which maketh 1908 English Miles.

PROB II.

Two Places differing only in Latitude, to find their Distance.

In this Problem are also two Cases.

I. IF the two places propounded, do differ only in Latitude, and lye both of them on one side of the Equinoctial, you must Substract the lesser Latitude from the greater, and the residue is the distance required.

Suppose therefore that one place have Latitude 22 Deg. 30 Min. *North*, and the other place 45 Deg. 50 Min. Now the difference is 23 Deg. 20 Min. which being converted into Miles, giveth the distance of the saidtwo places 1400 Miles.

II. But

II. But if the two places propounded lye, the one on the *North* side the Equinoctial, and the other on the *South* side, then you are to add the two Latitudes together, and the Sum will give their true distance

EXAMPLE.

Suppose one place have 45 Deg. 50 Min. *North* Latitude, and the other place have 21 Deg. *South* Latitude, therefore their aggregate 66 Deg. 50 Min. being converted into Miles, gives their distance 4010.

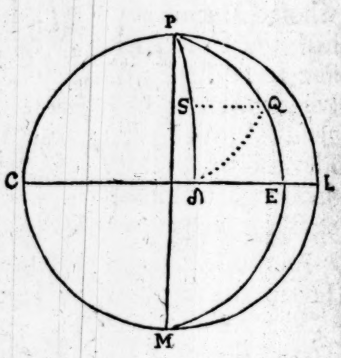
PROB. III.

Two Places being given, which differ both in Longitude and Latitude, to find their Distance.

In this Problem are also two Cases.

I. IF one of the Places is situate under the Equinoctial, and the other toward one of the Poles, then take this Example.

Let ♌ represent the City of *Arim* (which of the *Arabian Astrologers* is called the Middle of the World) whose Longitude is 109 Deg. 5 Min. and is situate right under the Equinoctial. And let Q represent the City of *Quinsai*, which hath Longitude 152 Deg. 20. Min. and *North* Latitude 40 Deg. the distance of which two places is shewed by the Arch ♌ Q. Wherefore in the Rectangled Triangle ♌ E Q are given (1.) ♌ E the difference of their Longitude, 43 Deg. 15 Min. (2.) E Q the Latitude of *Quinsai*, 40 Deg. (3.) ♌ E Q 90 Deg. Hence their distance ♌ Q is inquired.



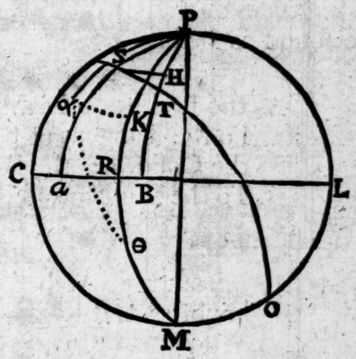
As the Radius 90 Deg.	10.00000
To the Cosin. of E Q 40 Deg.	9.88425
So the Cosin. of ♌ E 43 Deg. 15 Min	9.86235
To the Cosin. of ♌ Q 56 Deg. 5 Min.	9.74660

Now the Arch ♌ Q being reduced into miles, maketh 3365 *Italian* miles, which is the distance between *Quinsai* and *Arim*.

II. But if both the places are situate without the Equinoctial, their distance is to be sought by the solution of a Sphærical Triangle Obliquangle, as we shall demonstrate in the two following Examples.

EXAM-

EXAMPLE I.



Let us suppose S to represent the City of *London*, whose Latitude *a* S is 51 Deg. 32 Min. and T *Hierusalem*, whose Latitude is 32 Deg. 10 Min. Now the difference of the Longitudes of these two Cities is 45 Deg. 30 Min. Wherefore in the Oblique-angled Triangle S P T are given (1.) P S the Complement of the Latitude of *London*, 38 Deg. 28 min. (2.) P T the Complement of the Latitude of *Hierusalem*, 57 Deg. 50 min (3.) The included Angle S P T, 45 Deg. 30 Min.; Then to find their distance S T; I say, first

As the Radius	10.00000
To the Tangent of P S 38 Deg. 28 Min.	9.90008
So the Cosin. of the Angle S P T 45 D. 30 M.	9.84566
To the Tangent of P H 29 deg. 7 Min.	9.74574

(1)	deg.	min.
From the Arch P T.	57	50
Substract P H.	29	7
Remains T H.	28	43

(2)

As the Cosin. of P H 29 Deg. 7 Min.	9.94135
To the Cosin. of P S 38 Deg. 28 Min.	9.89374
So the Cosin. of H T 28 Deg. 43 Min.	9.94298
	19.83672
To the Cosin. of S T 38 Deg. 12 Min.	9.89537

Which maketh 2291 Miles, for the distance of *Hierusalem* from *London*.

EXAMPLE II.

Again, let us suppose the point α to represent the City of *Compostella*, which hath Longitude 15 Degrees 20 Min. Latitude 43 Deg. 0 Min. and let θ represent the *Promontorie* of *Good-hope*, whose Longitude is 49 Deg. 20 Min. Latitude 35 Deg. *South*. And lastly let α θ the distance between the two places be inquired.

Wherefore in the Triangle Oblique-angle P α θ are given, (1.) P α the Complement of the Latitude of *Compostella*, 47 Deg. (2) P θ 125 Deg. (which is the Aggregate of R θ the Latitude of the

the *Promontory* of *Good-hope*, 35 Deg. and P R 90 Deg. (3) the Included Angle α P θ 34 Deg. which is the difference of the Longitudes of the said two places. Hence their distance $\alpha\theta$ may be found as before.

(1)

As the Radius 90 Deg.	10.00000
To the Tangent of P α 47 Deg.	10.03034
So the Cosin. of the Angle α P θ 34 Deg.	9.91857
To the Tangent of P K 41 Deg. 38 Min.	9.94891

	deg.	*Min.*
From the Arch P θ	125	00
Substract P K	41	38
Rests K θ	83	22

(2)

As the Cosin. of P K 41 Deg. 38 Min.	9.87353
To the Cosin. of P α 47 Deg. 0 Min.	9.83378
So the Cosin. of K θ 83 Deg. 22 Min.	9.06295
	18.89673
To the Cosin. of α θ 83 Deg. 57 Min.	9.02320

Whereunto answereth 5037 *Italian* Miles, which is the distance required.

The End of the first Part.

THE
Art of Surveying.
BOOK. VIII.

PART II.

INTRODUCTION.

WE have already delivered ſuch *Problems Geometrical*, as are moſt neceſſary for every Surveyor to underſtand and Practice. And now to the end he may elevate and raiſe his Eyes (from off the Earth) to the contemplation of thoſe glorious Bodies, the *Sun*, *Moon*, and *Stars*, I ſhall here, in the laſt place, give him a brief Survey (as it were) of the firſt *Rudiments* of *Aſtronomy*, whereby he may (in his vacant Hours) get a competent Knowledge of ſuch concluſions, as are moſt meet and requiſite for his uſe and purpoſe. And firſt of all (that I may proceed in an orderly method) I ſhall give you a Brief and ſuccinct Explanation of the ſeveral Circles of the Sphere, and then ſhew how to reſolve and perform Artificially, all the moſt uſeful and common Problems thereof.

An Explanation of the Circles of the Sphere.

Firſt, I ſhall begin with the Equinoctial, otherwiſe called the Equator, which is the chief and principal Circle in the Sphere dividing the Heavens in the Middle between the two Poles: to which when the Sun cometh, he maketh the Days and Nights of an equal length throughout the World.

2. The Meridian is a great Circle paſſing through the *Poles* of the *World* and the *Zenith* of the place, unto which when the *Sun* cometh, it is Noon: The number of Meridians are as many as

there can be imagin'd Vertical Points, from the *West* to the *East*, whereof *Ptolomy* and other *Cosmographers* have described 180.

3. The *Vertical Point* or *Zenith*, is the Point directly over head, and is the Centre or Pole of the *Horizon*.

4. the *Nadir* is the opposite Point.

5. The *Horizon* is a great Circle dividing the visible part of the Heavens from the invisible; namely the superiour *Hemisphere* from the inferiour.

6. The *Zodiac* is a great Circle broad and slopewise, described upon its proper Poles, bearing the XII. Signs, and divideth the Equator into two equal parts, in the middle whereof is a line called the *Ecliptick*,* or the way of the *Sun*; from which the Latitude of the Planets are numbered both *Northward* and *Southward*: The Circumference of this Circle contains 360 Degrees; which is divided into 12 equal Parts called Signs, every one representing some living Creature, either in Shape or Property: Again, every Sign containeth 30 Degrees, every Degree 60 Minutes, every Minute 60 Seconds, and every Second 60 Thirds, &c.

7. The *Solsticial Colure* is a great Circle drawn through the Poles of the World, the Poles of the *Zodiack*, and the Solsticial points of *Cancer* and *Capricorn*.

8. The *Equinoctial Colure* is a Circle passing by the Poles of the World, and the Equinoctial points, which intersects the Colure of the Solstices at right Angles in the Poles of the World.

9. The *Tropick* of *Cancer* is a lesser Circle of the Sphere equally distant from the Equinoctial *Northward*, 23 Degrees 31 Minutes 30 Seconds, wherein when the Sun is, he is entring *Cancer*, making his greatest *Northern* declination.

10. The *Tropick* of *Capricorn* is also a lesser Circle of the Sphere, equally distant from the Equinoctial *Southward*, 23 degrees, 31 minutes, 30 seconds, to which when the Sun cometh (which is about the tenth of *December*) he maketh his greatest *Southern* Declination.

11. The *Circle Artick* is so far distant from the *North Pole* of the World, as the *Tropick* of *Cancer* is from the Equinoctial, to which it is parallel; and so much are the Poles of the Zodiac distant from the Poles of the World.

12. The *Circle Antartick* is also parallel to the Equinoctial, and is distant from the *South Pole*, as much as the Circle *Artick* is from the *North Pole*, viz. 23 degrees, 31 minutes, 30 seconds.

13. *Azimuth*, or *Verticle Circles* pass through the *Zenith*, and intersect the Horizon with right Angles, wherein the distance of the Stars, from any part of the Meridian are accounted, which is call'd the *Azimuth*.

14. *Circles* of *Altitude* (called the *Almicantherat*) are Circles parallel to the Horizon, and intersect the vertical Circles with right Angles, which are greatest in the Horizon, and meet together in the Zenith of the place; In which Circles, the Altitude of the Stars above the Horizon, are accounted.

15. *Circles* of *Position* pass by the common Sections of the Meridian and Horizon, and by the Centre of the Star.

16. Circles

16. *Circles* of the *Cælestial Houses*, are such as divide the Heavens into twelve equal Parts.

17. *Circles* of *Declination* are drawn through the Poles of the World, and Points of the Equator.

18. *Circles* of *Latitude* are those that pass through the Poles of the Ecliptick, and the Body of the Star.

19. The *Axis* (or Axel-tree) of the World, is a supposed streight line drawn from the *North* Pole to the *South* Pole, about which the Motions of the Stars and Planets are performed.

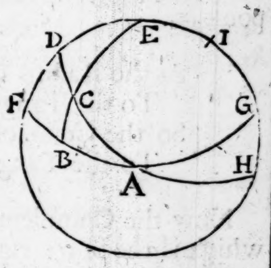
20. The *Elevation* of the *Pole* is the height thereof above the Horizon, which is equal to the *Zenith* and the *Equinoctial*, whose complement is equal to the distance of the *Zenith* from the *North Pole*, or to the Elevation of the *Equator* above the *Horizon*.

These Circles which are of most use, I here thought good to insert, for if these be not perfectly known my Reader cannot well understand the following Problems of the Sphere that depend thereupon.

PROB. I.

The Sun's place and greatest Declination being given, to find the Declination of any Point required.

IN this Diagram let D F H G represent the solstitial Colure, F A G the Equinoctial, D A H the Ecliptick, A the point of the vernal Equinox, E C B a Meridian line passing through E the Pole of the Equator by the Centre of the Sun at C, and falling upon the Equator G A F at Right Angles in the Point B. Also let the Angle D A F be the Sun's greatest Declination 23 Deg. 31 Min. A C the distance of the Sun from the begining of *Aries*, 30 Deg. and B C the declination of the Point sought Wherefore in the rectangled Sphærical. Triangle A B C, we have given (1) the Hypothenuse A C 30 Deg. (2) the Angle B A C 23 Deg. 31 Min. Hence to find B C, I say



As the Radius 90 Deg.	10.00000
To the sine of the Angle B A C 23 Deg. 31′	9.60099
So the sine of A C 30 Deg.	9.69879
To the sine of BC 11 Deg. 30′	9.29996

Which is the Sun's Declination required.

PROB. II.

The Sun's greatest Declination and his distance from the next Equinoctial point being given, to find his right Ascension.

IN the Triangle A B C we have given (as before) (1) The Angle of the Sun's greatest Declination B A C 23 Deg. 31 Min. (2) The Longitude of the Sun from the next Equinoctial point *Aries*, *viz.* A C 30 Deg. Hence, to find the right Ascension of the Sun A B, the Analogie is.

As the Radius 90 Deg.	10.00000
To the Tangent of A C 30 Deg.	9.76144
So the Cosin. of B A C 23 Deg. 31 Min.	9.96233
To the Tangent of A B 27 Deg. 53 Min	9.72377

Which 27 Deg. and 53 Min. is the Sun's right Ascension in 0 Deg. of *Taurus*: But here you are to observe, that if the right Ascension of the point sought, be in the Second Quadrant, ♋ ♌ ♍, then you are to take the complement of the Arch found to 180 Deg. if it be in the third Quadrant ♎ ♏ ♐, add a Semicircle to the Arch found; but in the last Quadrant, Substract the Arch found from the Circle 360 Deg. and you shall have the right Ascension desired.

II. Suppose the Sun in ♌ 60 Deg. from the Equinoctial point ♎.

As the Radius 90 Deg.	10.00000
To the Tangent of 60 Deg.	10.23856
So the Cosin. of 23 Deg. 31 Min.	9.96233
To the Tangent of 57 Deg. 48 Min.	10.20089

Now the Complement hereof to 180 Deg. is 122 Deg. 12 Min. which is the Sun's right Ascension in 0 Deg. ♌.

III. Suppose the Sun in ♏ 30 Deg. from the Equinoctial point ♎.

The work is the same as in the first Example, therefore to the Arch found 27 Deg. 53 Min. I add a Semicircle or 180 Deg. and the Sum 207 Deg. 53 Min. is the right Ascension of the Sun sought, in the first point of *Scorpio*.

IV. Suppose the Sun in ♒, 60 Deg. from the Equinoctial point. ♈.

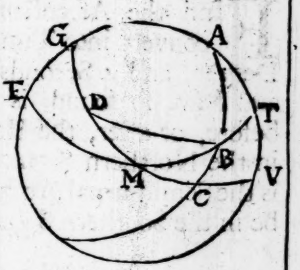
The Operation is the same with the Second Example, wherefore Substract the Arch found 57 Deg. 48 Min. from the whole Circle 360 Degrees, and there will remain 302 Deg. 12 Min. which is the Sun's right Ascension in the first point of *Aquarie*.

PROB.

PROB. III.

The Elevation of the Pole and Declination of the Sun being given, to find the Ascensional difference.

THE Ascensional difference is the quantity or difference between the Ascension of any point of the *Ecliptic* in a right Sphere, and the Ascension of the same point in an oblique Sphere.



In this Diagram, let A G E V represent the Meridian, E M S the Horizon, G M V the Equator, A T the Pole's Elevation, B C the Sun's Declination, B D an Arch of the Ecliptic, D C the right Ascension, M B the Amplitude of his Rising and Setting, M C the Ascensional difference. Wherefore in the rectangled Spherical Triangle B C M are known, (1.) The Angle B M C the Complement of the Pole's Elevation, 37 deg. 30 min. (2.) The Sun's Declination B C 11 deg. 30 min. Hence to find the Ascensional difference M C, I say,

As the Radius, 90 Deg.	10.00000
To the Contangent of B M C, 37 Deg. 30 Min.	10.11502
So the Tangent of B C, 11 Deg. 30 Min.	9.30846
To the Sine of M C, 15 Deg. 22 Min.	9.42348

PROB. IV.

The Sun's Right Ascension, and his Ascensional difference being given, to find his oblique Ascension and Descension.

TO perform this, you must observe the two following Rules.

1. If the Sun's Declination be North, you must Substract the Ascensional difference from the right Ascension, and the residue will be the oblique Ascension, but if you add them together, the sum will be the oblique Descension.

2. If his Declination be South, add the Ascensional difference and right Ascension together, the sum will be the oblique Ascension; but if you make Substraction, the Remainder will be the oblique Descension.

EXAMPLE.

Suppose the Sun be in the first point of *Taurus*, his right Ascension (by the second Problem) is 27 Deg. 53 Min. and his Ascensional difference (by the third) is 15 Deg. 22 Min. Therefore (according to the first Rule, because his Declination is North) the

the difference of them, 12 Deg. 31 Min. is the Sun's oblique Ascension, and the sum of them 43 Deg. 15 Min. is his oblique Descension.

PROB. V.

To find the Time of the Sun's Rising and Setting, with the length of the Day and Night.

FInd the Ascensional difference by the 3d Problem, which convert into Time, allowing 4 Min. of an Hour for every Degree, and 4 Seconds for every Minute, and the sum of Hours and Min. so found, is the difference of his Rising or Setting, before, or after, the Hour of Six. Therefore when the Sun is in the Northern Signs, add the same to Six, and the Aggregate is the Semidiurnal Arch, or Time of the Sun's Setting; but if he be in the Southern Signs, make Substraction.

Thus in the former Example:

The Sun being in 0 Deg. of *Taurus*, having 11 Deg. 30 Min. North Declination, his Ascensional difference is found by the 3d Problem, 15 Deg. 22 Min. which converted into time, (as is above shewed) maketh 1 Hour, 1 Min. 28 Sec. and because the Sun is in a Northern Sign, I add the same to Six Hours, and the sum 7 Hours, 1 Min. 28 Sec. is the time of the Sun's Setting, when he enters *Taurus*, in the Latitude of 52 Degrees and an half; whence it follows, that he riseth at 4 a Clock, 58 Min. and 32 Sec. that the length of the day is 14 Hours, 2 Min. 56 Sec. and the length of the Night 9 Hours, 57 Min. 4 Sec.

PROB. VI.

The Elevation of the Pole, and Declination of the Sun being given, to find his Amplitude of Rising and Setting.

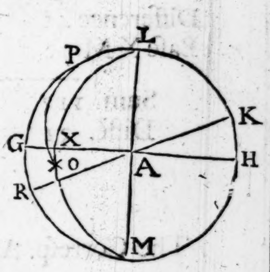
IN the right Angled Spherical Triangle B C M of the 3d Problem, having the Angle B M C the height of the Equator, 37 Deg. 30 Min. and B C the Sun's Declination in 0 Deg. of ♉, 11 Deg. 30 Min. his Amplitude M B may be thus found:

As the Sine of B M C, 37 Deg. 30 Min.	9.78445
To the Radius, 90 Deg.	10.00000
So the Sine of B C, 11 Deg. 30 Min.	9.29996
To the Sine of M B, 19 Deg. 8 Min.	9.51551

PROB.

PROB. VII.

The Elevation of the Pole, and Declination of the Sun being given, to find the just quantity of Twilight.



IN this Diagram, let L G M K represent the Meridian, G A H the Horizon, L the Zenith of the Place, M the Nadir, R A K the Equator, P the North Pole, O the Sun's Place in the Summer, X O the Depression of the Sun under the Horizon, 18 Deg. when the day-light is first of all said to break forth.

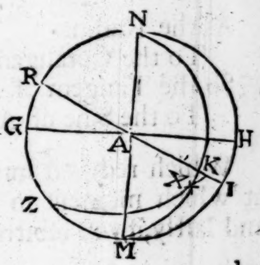
Now let us suppose, in the Latitude of 52 Deg. and an half, the Sun to be in 0 Deg. ♉, having North Declination 11 Deg. 30 Min. we shall then have in the Triangle O P L all the sides given, to find the Angle L P O, therefore, work thus:

Sides { P O 78°	30′	Com. of ☉ Decl. S.		9.99119	} Add.
Sides { P L 37	30	Com. of the Elev. S.		2.78445	} Add.
Difference 41	0			19.77564---1	
Base L O 180	0			20.00000---2	
Sum 149	0	Semisum 74°	30′	9.98391	} Add.
Diff. 67	0	Semidiff. 73	30	9.74189	} Add.
				19.72580---3	
Arch Correspondent 70 Deg. 46 Min.				19.95016---4	
		The half		9.97508	

Whose double 141. 32 is the Angle L P O, which converted into Time, maketh 9 Hours, 26 Min. 8 Sec. which is the time of Twilight, or Day-light ending, when the Sun enters *Taurus*, in the North Latitude of 52 Degrees and an half.

But if it be required to find the time of Twilight, when the Sun hath South Declination, then Substract the quantity of the Sun's Depression under the Horizon, 18 Deg. from the Quadrant 90 Deg. and there will remain the distance of the Sun from the Nadir 72 Deg. which done, the Operation will (in a manner) be the same as before.

EXAMPLE.



Let us suppose the Sun be in the opposite point to the former, *viz.* in 0 Deg. ♏, having South Declination 11 Deg. 30 Min. wherefore in the Triangle Z X M we have given, (1.) Z X the Complement of the Sun's Declination 78 Deg. 30 Min. (2.) X M the distance of the Sun from the Nadir, 72 Deg. (3) Z M the

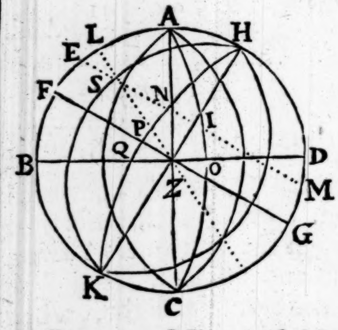
the Complement of the Elevation, 37 Deg. 30 Min. hence to find the Angle, X Z M the work will ſtand thus:

Sides { Z X	78°	30′	Com. ☉ Decl. S.	9.99119	} Add.
Sides { Z M	37	30	Com. Elevat. S.	9.78445	} Add.
Difference	41	0		19.77564----1	
Baſe X M	72	0		20.00000----2	
Sum	113	0	Semi. 56° 30′	9.92110	} Add.
Diffe.	31	0	Semi. 15 30	9.42690	} Add.
				19.34800----3	
				19.57236----4	
The Correſp. Arch,	37°	40′.	The half	9.78618	

Whoſe Double 75 Deg. 20 Min. is the Angle M Z X, which in Time is 5 Hours, 1 Min. 20 Sec. for the Time of Day-break, when the Sun enters ♏, in the Latitude of 52 Deg. and an half.

PROB. VIII.

The Latitude of the Place, and the Sun's Declination being given, to find the Time when he will be Eaſt or Weſt.



IN this Diagram, let A B C D repreſent the Meridian, F G the Equinoctial, B D the Horizon, H N K an Arch of the Sun's Meridian, A Z C the vertical Circle of the Eaſt and Weſt Points, E N M a Parallel of Declination; and laſtly, the Angle A H N, an Arch of the Equinoctial; F P is the term deſired.

Let us ſuppoſe the Sun in 0 *Gemini*, having North Declination, 20 Deg. 13 Min. and it's required to find the time when he will be due Eaſt or Weſt in the Latitude of 52 Deg. and an half.

Therefore in the right Angled Sphærical Triangle A H N are given, (1.) A H the Complement of the Pole's Elevation, 37 Deg. 30 Min. (2.) H N the Complement of the Sun's Declination, 69 Deg. 47 Min. then I ſay,

As the Radius	10.00000
To the Cotangent of H N 69 Deg. 47 Min.	9.56615
So the Tangent of A H 37 Deg. 30 Min.	9.88498
To the Sine of A H N 73 Deg. 35 Min.	9.45113

Which reduced into Time, giveth 4 Hours 54 Min. 20 Sec. at which moment in the Afternoon, the Sun will be due Weſt; and laſtly, if you ſubſtract the Hours and Min. thus found from 12, there

there remaineth 7 Hours, 5 Min. 40 Sec. for the Time in the Morning when he is due East.

PROB. IX.

The Elevation of the Pole, and Declination of the Sun being given, to find the Sun's Altitude when he cometh to be due-East or West.

IN the former Diagram, the Sun's Altitude when he is due-East or West, is shewed by the Arch N Z, wherefore in the Triangle Z Q N we have given, (1.) The Sun's Declination in 0 ♊, 20 Deg. 13 Min. (2.) The Angle of the Pole's Elevation, N Z Q, 52 Deg. 30 Min. hence to find his Altitude Z N, I say,

As the Sine of the Angle Q Z N, 52 Deg. 30 Min.	9.89946
To the Radius, 90 Deg.	10.00000
So the Sine of the ☉ Decli. QN, 20 Deg. 13 Min.	9.53854
To the Sine of his Altitude Z N, 25 Deg. 49 Min.	9.63908

PROB. X.

The Elevation of the Pole, and Declination of the Sun being given, to find the Sun's Altitude at the Hour of Six.

IN the Diagram of the 8th Problem, we have known, in the Triangle A I H, (1.) The Complement of the Pole's Elevation A H 37 Deg. 30 Min. (2.) The Complement of the Sun's Declination H I 69 Deg. 47 Min. Hence the Hypothenuse A I is inquired, therefore I say,

As the Radius, 90 Deg.	10.00000
To the Cosine of H I, 69 Deg. 47 Min.	9.53854
So the Cosine of A H, 37 Deg. 30 Min.	9.89945
To the Cosine of A I, 74 Deg. 5 Min.	9.43800

Whose Complement I O, 15 Deg. 55 Min. is the Sun's Altitude at the Hour of Six, when he enters *Gemini*, in the Latitude of 52 Deg. and an half.

PROB. XI.

The Latitude of the Place, and Declination of the Sun being given, to find the Sun's Azimuth at the Hour of Six.

IN the right Angled Spherical Triangle A H I of the last Diagram, we have known, (1.) A H the Complement of the Pole's Elevation 37 Deg. 30 Min. (2.) H I the Complement of the Sun's Declination 69 Deg. 47 Min. Hence to find the Azimuth of the Sun at the Hour of Six, represented by the Angle H A I, I say,

As the Radius, 90 Deg. 10.00000
To the Sine of A H, 37 Deg. 30 Min. 9.78445
So the Cotangent of H I, 69 Deg. 47 Min. 9.56615
To the Cotangent of H A I, 77 Deg. 22 Min. 9.35060

Which is the Azimuth of the Sun from the North part of the Meridian, at the Hour of Six, when he enters *Gemini*, in the North Latitude of 52 Degrees and an half.

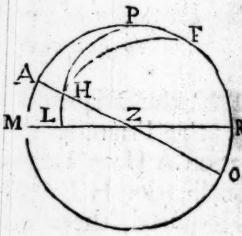
PROB. XII.

The Elevation of the Pole, the Declination of the Sun, and his Distance from the Meridian being given, to find the Sun's Altitude at any time assigned.

In this Problem are Three Cases.

First, *If the Sun be in the first Point of* Aries *or* Libra.

IN this Diagram, let P M R represent the Meridian, A Z O the Equator, M Z R the Horizon, H the place of the Sun, A H his distance from the Meridian, which (*for Example sake*) let us here suppose to be two Hours, or 30 Degrees.



Wherefore in the Triangle P A H, we have given, (1.) A P the distance of the Zenith from the Equator, equal to the Pole's Elevation, 52 Deg. 30 Minutes. (2.) A H the distance of the Sun from the Meridian, 30 Deg. Hence to find the Sun's Altitude L H, I say,

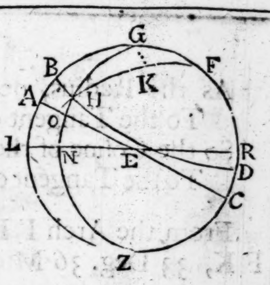
As the Radius, 90 Deg. 10.00000
To the Cosine of A H, 30 Deg. 9.93753
So the Cosine of A P, 52 Deg. 30 Min. 9.78445
To the Cosine of P H, 58 Deg. 11 Min. 9.72198

Whose Complement L H, 31 Deg. 49 Min. is the Sun's Altitude required.

Secondly, *When the Sun is in the North Signs*, ♈, ♉, ♊, ♋, ♌, ♍.

In the Diagram annexed, let G L Z R represent the Meridian, A E C the Equinoctial, F the North Pole of the World, L E R the Horizon, G the Zenith, B H D a Parallel of the Sun's Declination, F H O the Meridian of the Sun, B H B F H the distance of the Sun from the Meridian of the place, O H the

the Sun's Declination North, G F the Complement of the Pole's Elevation.



Let it be required to find the Sun's Altitude at 9 of the Clock before Noon, when he enters *Gemini*, in the North Latitude of 52 Deg. 30 Min. wherefore in the Triangle F G H we have known, (1.) G F the Complement of the Pole's Elevation, 37 Deg. 30 Min. (2.) F H the Complement of the Sun's Declination, 69 Deg. 47 Min. (3.) The comprehended Angle G F H, the distance of the Sun from the Meredian 30 Deg. Hence to find G H, and consequently the Sun's Altitude N H, I say,

(1.)

As the Radius, 90 Deg.	10.000000
To the Tangent of F G, 37 Deg. 30 Min.	9.88498
So the Cosine of the Angle G F H, 30 Deg.	9.93753
To the Tangent of F K, 33 Deg. 36 Min.	9.82251

From the Complement of the Sun's Declination F H, 69 Deg. 47 Min. Substract F K, 33 Deg. 36 Min. there remains K H, 36 Deg. 11 Min.

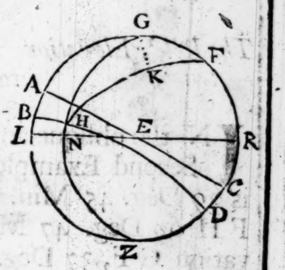
(2.)

As the Cosine of F K, 33 Deg. 36 Min.	9.92060
To the Cosine of G F, 37 Deg. 30 Min.	9.89946
So the Cosine of K H, 36 Deg. 11 Min.	9.90694
	19.80640
To the Cosine of G H, 39 Deg. 45 Min.	9.88580

Whose Complement N H, 50 Deg. 15 Min. is the Sun's Altitude above the Horizon, at 10 a Clock in the Morning, or at 2 in the Afternoon, when he enters *Gemini*, in the Latitude of 52 Deg. and an half, North.

Thirdly, *When the Sun is in the Southern Signs*, ♎, ♏, ♐, ♑, ♒, ♓.

Suppose the Sun in the Winter Season be in the opposite Point to the former, having Southern Declination, 20 Deg. 13 Min. and be also distant from the Meridian 30 Deg. therefore in this Diagram, we have given, in the oblique-angled Triangle G F H (1.) F G as before, 37 Deg. 30 Min. (2.) F H 110 Deg. 13 Min. the sum of the Quadrant added to the Sun's Declination, (3.) The Angle G F H, 30 Deg. Hence to find the Sun's Altitude N H, I say, as before.



 (1.) As

(1.)

As the Radius, 90 Deg.	10.00000
To the Tangent of F G, 37 Deg. 30 Min.	9.88495
So the Cosine of the Angle G F H, 30 Deg.	9.93753
To the Tangent of F K, 33 Deg. 36 Min. as before	9.82251

From the Arch F H, 110 Deg. 13 Min. substract the Arch F K, 33 Deg. 36 Min. and there rests K H, 76 Deg. 37 Min.

(2.)

As the Cosine of F K, 33 Deg. 36 Min.	9,92060
To the Cosine of G F, 37 Deg. 30 Min.	9.89946
So the Cosine of K H, 76 Deg. 37 Min.	9.36448
	19.26394
To the Cosine of G H, 77 Deg. 16 Min.	9.43343

Now the Complement of G H is N H, 12 Deg. 44 Min. which is the Sun's Altitude required.

PROB. XIII.

The Sun's Altitude, his Distance from the Meridian, and Declination being given, to find his Azimuth.

IN the oblique-angled Sphærical Triangle G F H of the 2d Diagram of the last Problem, we have known, (1.) G H the Complement of the Sun's Altitude, 39 Deg. 45 Min. (2.) The Angle G F H the distance of the Sun from the Meridian, 30 Deg. (3.) F H the Complement of the Sun's Declination, 69 Deg. 47 Min. Then to find the Sun's Azimuth, I work thus:

As the Sine of G H, 39 Deg. 45 Min.	9.80580
To the Sine of the Angle G F H, 30 Deg.	9.69897
So the Sine of F H, 69 Deg. 47 Min.	9.97238
	19.67135
To the Sine of F G H, the Sun's Azimuth, 47 D. 12 M.	9.86555

PROB. XIV.

The Pole's Elevation, with the Sun's Altitude and Declination given, to find the Sun's Azimuth.

IN the oblique-angled Triangle G H F of the 12th Problem, Second Example, the Complement of the Sun's Altitude G H is 39 Deg. 45 Min. the Complement of the Sun's Declination F H 69 Deg. 47 Min. and the Complement of the Pole's Elevation G F, 37 Deg. 30 Min. which known you may frame your Operation thus:

Sides

Sides GH	39 Deg.	45 Min.			9.805807	Add
GF	37	30			9.78445	
Difference	2	15			19.59025-----1	
Base FH	69	47			20.00000-----2	
Sum	72	2	Semi. 36°	1',	9.769397	Add
Difference	67	32	Semi. 33	46	9.744933	
					19.51432-----3	
					19.92407-----4	

The Corresp, Arch 66° to half 24' 9.96203

Whose double 132 Deg. 48. Min. is the Angle F G H, now the Complement thereof 47 Deg. 12 Min is the Angle B C H, which is the Sun's Azimuth as before.

The End of the Second Part.

THE

THE
Art of Surveying.
BOOK. VII.
PART III.

INTRODUCTION.

WE now proceed to give our Surveyor ſome *Problems* of *Horologiography*, ſhewing how to Calculate and Deſcribe the *Horizontal*, and all ſorts of *Mural Sun-Dials*, whether *Direct* or *Declining*: And (though it is not our intention in this place to Treat of the whole Art of *Dialling*, yet) we ſhall ſhew him, how he may deſcribe the moſt uſual ſorts, which are the *Horizontal*, the direct North and South, and the Eaſt and Weſt Plans, together with the erect North and South Plans, declining Eaſt and Weſt to any Declination given, according to the Projection of the Sphere.

PROB. I.

To Deſcribe the Horizontal Dial.

FIrſt we ſhall begin with the Horizontal, which is ſuch a Plane, as is Parallel to the Horizontal Circle of the Sphere, whoſe Poles lie directly in the Zenith and Nadir of the place of your Habitation.

Before we come to the Calculation of the Hour-diſtances, draw the Meridian Line C A B, and croſs the ſame with the Line D E, at right Angles, in the Point A, which Interſection muſt be the Centre of your Dial, and the Line ſo drawn, *viz.* D E is the Six a Clock-Line, then to draw the other Hour-Lines, ſay,

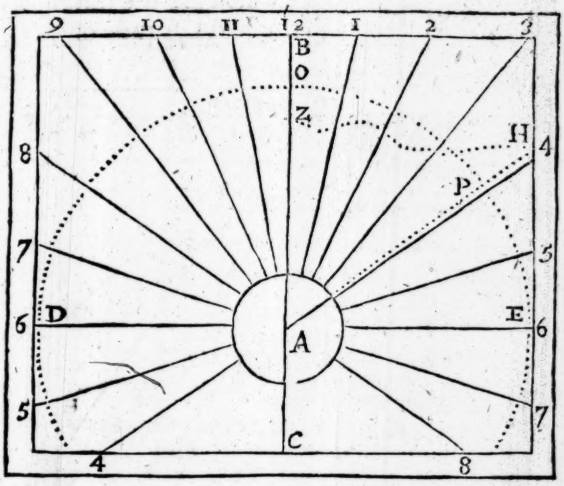
As

As the Radius, is to the Sine of the Pole's Elevation;
So is the Tangent of the Hour-Lines at the Pole,
To the Tangent of the distance of the Hour from the Meridian.

Let the Question be to Supputate the distance of the Eleven, or One a Clock Hour from the Meridian in the Latitude of 52 Deg. and 30 Min. therefore according to the former Analogy, it may thus be Resolved.

Radius 90 Deg.	10.00000
Sine of the Pole's Elevation, 52 Deg. 30 Min.	9.89946
Tangent of the Equinoctial distance of One Hour from the Meridian 15 Deg.	9.42805
Tangent of the Hour from the Meridian, 12 deg.	9.32751

After this manner may you find the distance of 2 and 10 of the Clock, and of 3 and 9 of the Clock, and so of the rest; only you are to remember, that the Equinoctial distance of 1 a Clock is 15 Deg. of 2 a Clock 30 Deg. of 3 a Clock 45 Deg. of 4 a Clock 60 Deg. of 5 a Clock 75 Deg. as in the following Table.



The distance of the Hour-Lines from the Meridian being now found, you may project them into the former Scheme thus.

Hours		Equin. distanc.		Hour Arches.	
12		0	0	0	0
11	1	15	0	12	0
10	2	30	0	24	37
9	3	45	0	38	26
8	4	60	0	53	57
7	5	75	0	71	20
6	6	90	0	90	0

Take with your Compasses 60 Deg. from a Line of Chords, and with the same Extent, setting one Foot in the Centre A, with the other describe the Circle D O E, which done, take from the same Scale of Chords, all the Hour-distances, and placing one foot of your Compasses in O, (where the Circle Intersects the Meridian) with the other set out the Hour distances before found by Calcula-

tion,

tion, both ways upon the Circle D O E, then drawing ſtreight Lines from the Center A, to thoſe Pricks in the Circle, you ſhall have the true Hour-lines deſired.

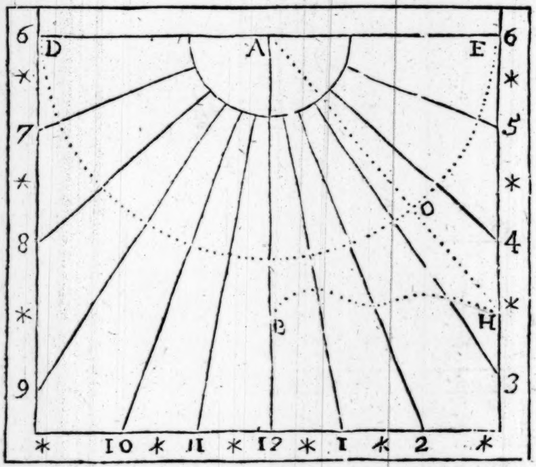
Laſtly, From the ſaid Line of Chords, take the Pole's Elevation, 52 Deg. 30 Min. and ſet it from O to P, drawing the Prickt Line A P H, which ſhall repreſent the upper edge, or height of the Style; ſo will Z A H be the true Pattern of the Cock, or Gnomon of your Dial, which erect at right Angles over the 12 a Clock Line, and ſo is your Dial finiſhed.

PROB. II.

To deſcribe the Erect, Direct North or South Dial.

THe making of this differs very little from the Horizontal, only there in the Calculative part, you took the Pole's Elevation, but here you muſt take its Complement, and inſert only 12 Hours, as will appear by the following Figure.

Let the Queſtion again be to Calculate the diſtance of 11, or 1 a Clock from the Meridian, in the ſaid Latitude of 52 D. 30 Min.



The Calculation.

As the Radius, 90 Deg.	10.00000
To the Coſine of the Pole's Elevation, 52° 30′	9.78445
So the Tangent of the diſtance of one Hour from the Meridian, 15 Deg.	9.42805
To the Tang. of the Hour Arch from 12, 9° 16′	9.21250

According to the like Order are the reſt of the Hour Arches found, as in the Table.

The

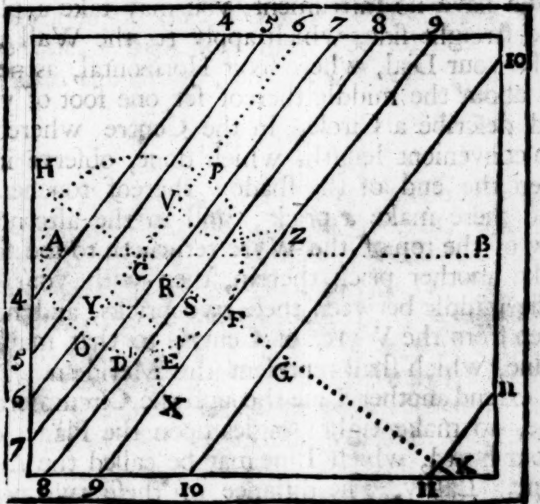
The distance of the Hour-Lines from the 12 a Clock Line being now found, you must Project them into the Dial after the same manner, as we shewed in the Horizontal, only for the height of the Style, you are to take the Complement of the Pole's Elevation, 37 Deg. 30 Min. and then work as before, as you may see by the Diagram.

Hours		Equin. distanc.		Hour Arches.	
12		05	0	0	0
11	1	15	0	9	16
10	2	30	0	19	22
9	3	45	0	31	20
8	4	60	0	46	31
7	5	75	0	66	15
6	6	90	0	90	0

PROB. III.

To Describe the direct East or West Dial.

First draw the Horizontal Line of the Plane A B, and this Dial may most exactly be projected by a Line of Natural Tangents, but we shall here give you that way which is more easie, and fitting all Capacities.



Let the Subſtylar Line (which stands in the Line of 6) make an Angle therewith, equal to the Latitude of the Place, as 6 C B, so that it may point exactly to the Pole of the World; then from the point C, draw the Line H C K, at right Angles to the 6 a Clock Line. Next upon C, as a Centre, describe a Circle, whose Radius shall be equal to the height of the Style G F, which prick off from O to E, from F to D, from E to G, and from G twice

 to

to K. Lastly, Lay a Rular from P to D, and it will Intersect the Line H K in the point R, where make a prick for the 7 a Clock Line. Again, Lay the Rular from P to E, and you shall find it to cut the Line H K in S for the 8 a Clock Line. The 9 a Clock Line is at the point F, the 10 a Clock Line at the point G, and the 11 a Clock Line at the point K; then from every of the said points draw Lines parallel to the substyle, or Hour-Line of 6, and you shall have six of the Hour-Lines inserted. Lastly, Make the Hour-Lines of 5 and 4 in the morning, as far distant from the Substyle towards the Left-Hand, as the Lines of 7 and 8 are towards the Right, and then is your Dial compleatly finished; only remember to set your Gnomon erect over the Line O P.

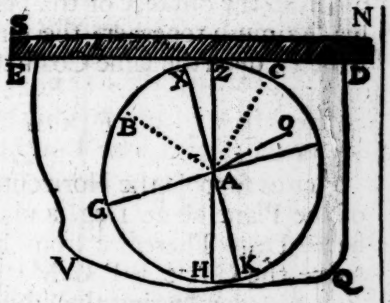
PROB. IV.

To find the Declination of a Plane.

IF the Plane whereon you are to make your Dial, behold neither the East, West, North or South Points of the World, but Decline therefrom, then it will be necessary to shew how to find the Declination thereof, which may be obtained several ways, both by the assistance of Instruments, and other ways. First, If you have no Instrument, you may take a plain Board, having one streight side, which apply to the Wall where you intend to set your Dial, where fix it Horizontal, as near as you can; then about the middle thereof set one foot of your Compasses, and describe a Circle, in the Centre whereof erect a Wyre of a convenient length, which done, observe in the forenoon, when the end of the shadow thereof toucheth the said Circle, and there make a prick; and in the afternoon, when the shadow of the top of the Wyre returneth to the same Circle again, make another prick therein, then with your Compasses measure the middle between these two pricks, and there make a mark; then from the Wyre, or Centre, to that mark, draw a streight Line, which shall represent the Meridian. Next from the Wyre extend another Line through the Circumference of the said Circle, to make right Angles upon the Plane, or streight edge of your board, which Line may be called the Axis or Pole of the Plane. Lastly, The distance of these two pricks in the Circumference of the Circle, is the true Declination of the Plane, which you may know at first sight, whether it be North or South, by ocular Inspection only.

EXAMPLE.

Let S N D E represent the face of the Plane, whereon I am to make my Dial, to which I apply the streight edge of the board



board D E, as in this Figure. Then about the middle of the board D E V Q, *viz.* at A, I ſet one foot of my Compaſſes, and with the other (opened to 60Deg.upon my Line of Chords) I deſcribe the Circle Z B H C, in the Centre whereof A, I erect a Wyre, as A O, which done, I find by Obſervation, that the ſhadow of the top of the Wyre, toucheth the Circle in the Forenoon, at the point B, where I make a little mark. Likewiſe I obſerve in the Afternoon, that it toucheth the ſaid Circle in the point C, then I meaſure their diſtance with my Compaſſes, and ſet the half thereof from B or C to X, and drawing a Line with my Rular from A to X, we ſhall have the Meridian Line K A X exactly deſcribed.

Laſtly, Opening my Compaſſes, I take the diſtance Z X, which I apply to my Scale of Chords, and find the Arch thereof 18 Deg. 10 Min. and ſo much is the Declination of the Plane E D N S, which you may ſee by the Meridian Line K X, is towards the Weſt. This then is a South Plane declining Weſt, 18 Deg. 10 Min.

Although this way of finding the Declination of a Plane, is moſt eaſie, yet becauſe it requires Obſervation both in the forenoon and afternoon, ſo that it cannot be effected without ſome conſiderable time, I ſhall now ſhew you another way or two, how to perform the ſame at one Obſervation.

Otherwiſe.

You may find the Declination of any Plane by the *Sun's* Azimuth; for, take his Altitude with a Quadrant, and by the laſt Problem of the former Part, calculate his Azimuth; at the ſame inſtant, apply one edge of the Quadrant to the Plane, that the Limb thereof may be towards the Sun, then placing the Quadrant as near level as you can, hold up a Thread and a Plummet, in ſuch wiſe, that the ſhadow of the Thread may fall upon the Centre and Limb of the Quadrant, then will the ſhadow ſhew upon the Limb how many Degrees the Sun is diſtant from that ſide of the Quadrant which repreſents the Axis, or Pole of the Plane, which may be called the diſtance of the Sun from the Pole of the Plane.

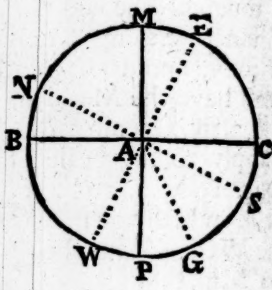
Again, At the ſame inſtant obſerve the Sun's Altitude by your Quadrant, by which you may get his Azimuth from the South point, as is ſaid before. Then to find the Declination, obſerve the two following Rules.

1. If the ſhadow fall between the South, and the Perpendicular ſide of the Quadrant, that repreſents the Axis of the Plane,

then add the distance of the Sun from the Pole of the Plane, and his Azimuth together, the sum is the Declination of the Plane, which is upon the same Coast the Azimuth is, as for Example.

EXAMPLE I.

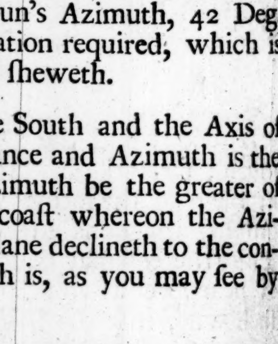
Let us suppose the Horizontal distance of the Sun from the Pole of the Plane be 20 Deg. and the Sun's Azimuth from the South be 42 Deg. Therefore from hence to find the Declination, I describe the Circle B P C M, whereupon I draw the Diameter B A C, representing the Horizontal Line of the Plane, and cross it at right Angles in the Centre A, with the Diameter M A P, which represents the Pole of the Plane. Then with my Compasses, I take from the Scale of Chords, the Horizontal distance, or distance of the *Sun* from the Pole of the Plane, 20 Deg. and set it from P to G, and then from G to S set off the Sun's Azimuth, 42 Deg. which done, draw the Diameter S N, and cross it at right Angles with the Diameter E A W, so will S represent the South, N the North, E the East, and W the West. Now forasmuch as the Line of the shadow of the Thread G A, falleth between P the Pole of the Plain, and S the South point; therefore according to the former Rule, I add P G the Sun's distance from the Pole of the Plane 20 Deg. to G S the Sun's Azimuth, 42 Deg. and the sum P S 62 Deg. is the Declination required, which is towards the West, as the Figure it self sheweth.



2. If the shadow fall not between the South and the Axis of the Plane, then the difference of the distance and Azimuth is the Declination of the Plane; and if the Azimuth be the greater of the two, the Plane declines to the same coast whereon the Azimuth is; but if it be the lesser, then the Plane declineth to the contrary Coast to that whereon the Azimuth is, as you may see by this Example.

EXAMPLE II.

Admit the Sun's distance from the Pole of the Plane be taken in the afternoon 70 Deg. and the Sun's Azimuth from the South be then given, 44 Deg. Therefore, as before, I draw the Circle M C P B, and from P to H, I set off the Sun's distance from the Pole of the Plane 70 Deg. and from H to S the Sun's Azimuth 44 Deg. now because the South point doth fall between



P the

P the Pole of the Plane, and H the distance of the Sun from the Pole of the Plane; therefore (according to the Rule) I substract the Sun's Azimuth H S, 44 Deg. from H P the distance of the Sun from the Pole of the Plane, and there remaineth S P 26 Deg. the Declination desired; which is towards the East, as you may perceive by the Figure. So that this is a South Plane declining East 26 Degrees.

EXAMPLE III.

Although the two former ways are exact, if they are but warily performed, yet in regard they cannot be effected without the help of the Sun, I shall therefore shew how you may speedily find the Declination of any Plane by the Needle, whether the Air be clear or not.

Apply the North side of the Instrument, wherein the Needle is placed unto the Wall, and hold it Horizontally, as near as you can, that the Needle may have free liberty to play to and fro, and when it stands, observe upon the Limb of the Chard, over which it moves, upon what Degree the Needle stands, for that is the Declination reckoned from the South. And if you would know the Coast, observe that if the Needle stand upon the East side the Meridian Line, then is the Declination of the Plane West, but if it stand on the West side the Meridian Line, the Declination is East, according to the quantity thereof.

PROB. V.

To describe the North and South erect Declining Dial, according to its Declination East or West.

First the Declination of the Plane, whereon you intend your Dial, is to be sought, as was shewed in the last Problem, which being attained, we shall come to the Declination of the Dial it self.

Let us suppose the Elevation of the Pole to be 52 Deg. 49 Min. and the Declination of the Plane whereon I am to make my Dial, be 24 Deg. towards the West, (such was one of the Dials I lately made for the Right Worshipful Sir *Erasmus de la Fountain*, at *Kerby-Bellers* in the County of *Leicester*) therefore, because the Declination is West, the Style must stand on the East side the Meridian, or Hour-Line of 12, (but if the Declination had been East, it should have stood on the West side thereof). But before we can come to the Calculation of the Hour-distances, there are three things to be known, (1.) The Elevation of the Pole above the Plane, commonly called the height of the Style; (2.) The distance of the Substile from the Meridian; (3.) The Inclination of the Meridian of the Plane to the Meridian of the place.

The

The Calculation.

(1.)

As the Radius, 90 Deg.	10.00000
To the Cosine of the Elevation, 52° 40′.	9.78279
So the Cosine of the Declination, 24 Deg.	9.96073
To the Height of the Style, 33° 38′	9.74352

(2.)

As the Radius, 90 Deg.	10.00000
To the Sine of the Declination, 24 Deg.	9.60931
So the Cotangent of the Elevation, 52° 40′	9.88236
To the Tangent of the Substile's distance from the Meridian, 17° 14′	9.49167

(3.)

As the Radius, 90 Deg.	10.00000
To the Sine of the Pole's Elevation, 52°. 40′	9.90043
So the Cotangent of the Declination, 24 Deg.	10.35142
To the Cotangent of the Inclination of the Meridian, 29 Deg. 15 Min.	10.25185

These things thus found, we shall next proceed to the Calculation of the Hour-distances: But first we are to consider, That the Angle between the Meridians was found to be 29 Deg. 15 Min. and because the Hour of One is distant from the Meridian 15 Deg. and the Hour of Two 30 Deg. therefore I conclude the Substile will fall between one a Clock and two; and if I Substract 15 Deg. from 29 Deg. 15 Min. the Remainder will be 14 Deg. 15 Min. the distance of the one a Clock-Line from the Substile.

Again, The distance of two of the Clock from the Meridian, is 30 Deg. from which if I Substract, 29 Deg. 15 Min. the distance of the two a Clock from the Substile, will be 0 Deg. 45 Min. These things being now known, the rest of the Hours are found by a continual addition of 15 Deg. for every Hour, (and for every half hour 7 Deg. 30 Min. *&c.*) as by the following Table you may perceive. Lastly, To find the distance of each Hour-Line from the Substile, we shall give an Example for one of the Clock, whose Equinoctial distance from the Substile, is (as in the following Table) 14 Deg. and 15 Min.

The Calculation.

As the Radius, 90 Deg.	10.00000
To the Sine of the Height of the Stile, 33° 38′	9.74341
So the Tangent of the distance of one Hour, from the Substile, 14 Deg. 15 Min.	9.40478
To the Tangent of the Hour Arch from the Substile, 8 Deg.	9.14819

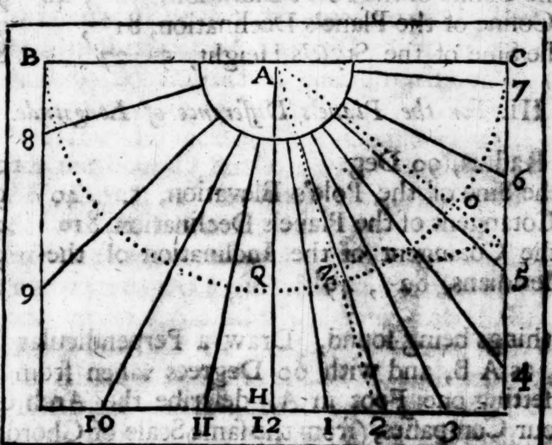
After

After the same manner we have Calculated the following Table, by which the Dial is most easily projected, as we shall hereunder shew.

Hours	Equin. distanc.		Hour Arches.	
8	89	15	88	39
9	74	15	63	1
10	59	15	42	57
11	44	15	28	21
12	29	15	17	14
1	14	15	8	0
	Merid.		Substile	
2	0	45	0	25
3	15	45	8	53
4	30	45	18	14
5	45	45	29	37
6	60	45	44	41
7	75	45	65	22

First, Draw the Horizontal-Line B C, (as in the following Figure) and from the most convenient place thereof, as A; let fall the Perpendicular A H, which shall represent the Meridian Line of the Plane. Then take 60 Deg. from a Line of Chords, and making the Centre, draw the Semicircle, B Z C. In this Circle from Q to Z prick down the distance of the Substyle from the Meridian, which was found before, 17 Deg. 14 Min. and from the Substyle Z, in the same Circle, I set off the height of the Style to O, 33 Deg. 38 Min. so shall Z A O represent the Cock of the Dial. Then from the same Scale of Chords, take off with your Compasses, the several Hour-distances, as they are ready Calculated in the Table, *viz.* 8 Deg. 0 Min. for 1 a Clock; 17 Deg. 14 Min. for 12 a Clock; 28 Deg. 21 Min. for 11 a Clock, and

An Erect Dial, Declining from the South, Westward 24 Degrees.



so of the rest, and prick them down from the Substyle, in the Circle B Q C, by help of your Line of Chords. Lastly, Draw streight Lines from the Centre A, to those several Points, and you shall have the true Hour-Lines, which was desired.

PROB.

PROB. VI.

The Calculation and Projection of an Erect South Plane, declining Eastward, 81 Degrees.

ACcording to this Method, I shall here take, the Style may be so proportioned, by the Discretion of the Artist, to fill any Plane, by bare Inspection.

The First thing to be found, is, The distance of the Substyle from the Meridian: Secondly, The Elevation of the Pole above the Plane, commonly known by the name of the Style's height: And Thirdly, The Plane's difference of Longitude, or Inclination of Meridians: The Calculation follows.

I. *For the Substyle's Distance.*

As the Radius, 90 Deg.	10.00000
To the Sine of the Plane's Declination, 81 Deg.	9.99461
So the Cotangent of the Pole's Elevation, 52° 40′	9.88236
To the Tangent of the Substyle's Distance from the Meridian, 37°.	9.87697

II. *For the Style's Height.*

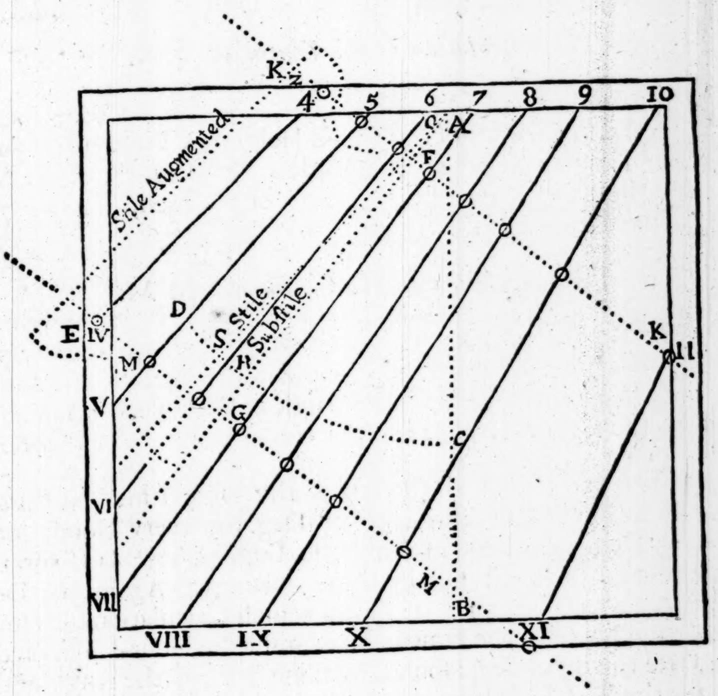
As the Radius, 90 Deg.	10.00000
To the Cosine of the Pole's Elevation, 52°, 40′	9.78279
So the Cosine of the Plane's Declination, 81°,	9.19433
To the Sine of the Style's Height, 5° 27′	8.97712

III. *For the Plane's Difference of Longitude.*

As the Radius, 90 Deg.	10.00000
To the Sine of the Pole's Elevation, 52° 40′	9.90044
So the Cotangent of the Plane's Declination, 81°	9.19971
To the Cotangent of the Inclination of the Meridians, 82°, 49′	9.10015

These things being found, Draw a Perpendicular Line upon the Plain, as A B, and with 60 Degrees taken from a Scale of Chords, setting one Foot in A, describe the Arch C D; then take in your Compasses, (from the same Scale of Chords) 37 Deg. the Substyle's Distance, and set it from C to R, and draw the prickt Line A R for the Substyle; this done, Take from the Scale of Chords, 5 Deg. 27 Min. the Style's Height, and set it from the Substyle, where it intersects the Circle, as from R to S, and draw the Line A S for the Stile; then consider the bigness of your Plane, so as you may Augment the Style, that the Hour-Lines may fill the Plane, which in this Example, or Dial, we shall raise 9 Inches, as the Line E Z, parallel to the Line S O, so

ſo will the Style be augmented; then make choice of two Points in the Subſtyle, as at F and G, and draw the two Contingent Lines, as M M and K K at right Angles with the Subſtyle; then



meaſure the Height of your augmented Style, in both the Contingent Lines, in Inches and Decimal parts, as from G to E, which I find to be 14 Inches, and from F to Z 11 Inches, which two numbers are to be made uſe of in the Calculation of the ſeveral Hour-diſtances: Next, Conſidering the Inclination of Meridians was found, 82 D. 49 M. therefore allowing for every Hour 15 Deg. being the Angle at the Pole, ſo that I find the Subſtyle will fall between the Hours of 6 and 7; for if I Subſtract 82 D. 49 M. from 90 Deg. (being 6 hours from the Meridian, for 6 times 15 is 90) the Remainder is 7 D. 11 M. for the Diſtance of the 6 a Clock-Line from the Subſtyle, being the Angle at the Pole for that Hour; ſo likewiſe if I Subſtract 75 Deg. (the Angle at the Pole for the Hour of 7) from 82 Deg. 49 M. the Remainder is 7 D. 49 M. for the Angle at the Pole for the Hour of 7; thus, having theſe things, we ſhall proceed to Calculate the ſeveral Hour-diſtances from the Subſtyle, which are to be ſet off from the Subſtyle in both the Contingent Lines, therefore two Arches muſt be Calculated for each Hour by this Analogy. As the Radius to the Logarithm of the Style's Height in Inches, (in either of the Contingent Lines) ſo the Tangent of the Angle at the Pole, to the Logarithm in Inches for that Hour-diſtance from the Subſtyle, and ſo for the diſtance in

in Inches and Parts, in the other Contingent Line for the ſame Hour, as ſhall here be demonſtrated in the 6 a Clock Line, being the firſt Line on the upper ſide the Subſtyle, whoſe Angle at the Pole was found 7 D. 11 M.

The Calculation in the Contingent K K.

As the Radius, 90 Deg.	10.00000
To the Logarithm of the Style's Height, 11 Inch.	1.04139
So the Tangent of 7° 11′ the Angle at the Pole.	9.10048
To the Logarithm of 1,$\frac{39}{100}$ Parts of an Inch, the Hour-Arch.	0.14187

The Calculation in the Contingent M M.

As the Radius, 90 Deg.	10.00000
To the Log. of the Style's Height, 14 Inches.	1.14612
So the Tangent of 7° 11′ the Angle at the Pole.	9.10048
To the Log. of 1. $\frac{76}{100}$ Inch. the Hour-Arch.	0.24660

By this Analogy may all the reſt of the Hour-Lines be Calculated by a continual Addition of 15 Deg. for every Hour; for if I add 15 Deg. to 7 Deg. 11 Min. the Sum is 22° 11′ for the Hour of 5 to be found by the ſame Analogy: Again, 15 Deg. added to 22° 11′, is 37° 11′, from which Calculation the Hour-Line of 4 is found, in the ſame manner muſt the Hour-Lines on the other ſide the Subſtyle be found, by uſing 7° 49′ the Angle at the Pole for the 7 a Clock-Line, which by the former Analogy will give the Hour-Arch for 7 a Clock, to which 7° 49′ add 15 Deg. and by the ſame Proportion find the Hour-Arch for 8, and ſo by the continual Addition of 15 Deg. uſed by the ſame Analogy, may the reſt of the Hour-Arches be found, which may moſt eaſily be projected into the Dial from the ſeveral Calculations, by taking the Hour-Arches in Inches and Parts, and placing them from the Subſtyle F and G, upon their proper Contingent Lines, through the Plane, the Gnomon, (or Style) ſet directly over the Subſtyle, and the Work is finiſhed.

Theſe are all the ſeveral ſorts of Mural Dials that are properly affixed upon Buildings, which the Surveyor is very often put upon to do, but if he have a deſire to make a further progreſs in this Gnomical Science, I ſhall wholly recommend him to Mr. *Leybourn*'s Dialling in Folio, where the Art is Treated of fully in all its parts, it being the only Piece in that Kind extant.

PROB.

PROB. VII.

To find the true Hour of the Day by the ſhadow of a Staff erected Perpendicularly upon plain level Ground, where the Sun doth ſhine, the Staff being divided into 10, 100, *or* 1000 *Parts.*

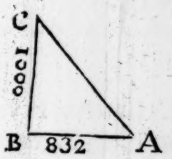
THis Problem may beſt be effected by the following Table, which is Calculated by the Solution of a Plain Rectangled Triangle, according to the firſt Problem of the Third Book, for we have given, (1.) The length of the Staff C B 1000. (2.) The Angle of the Sun's Altitude, B A C, to find the Length of the Shadow A B.

Admit the Sun be in the firſt Point of *Gemini*, and at two a Clock in the Afternoon, it is required to find the length of the Shadow of the Staff. By the 12th Prob. of the 2d Part of this Book, the Sun's Altitude is found, 15 D. 15 M. repreſented by the Angle B A C; which known, with the length of the Staff B C 1000, to find B A, I ſay,

As the Radius, 90 Deg.	10.00000
To the Cotang. of the Angle, B A C, 15° 15′	9.91996
So the Length of the Staff, B C 1000.	3.00000
To the Length of the Shadow, 832.	2.91996

According to this Doctrine was the following Table compoſed, which I ſhall here Explain.

Firſt, The Staff or Gnomon is here ſuppoſed to be divided into 1000 equal Parts, and being ſet upright, the Table will ſhew (according to the Sun's Place) how many ſuch Parts, the length of the Shadow thereof is to contain, at any Hour of the Day.



Secondly, If the Staff be divided into 100 Parts, the Figures towards the Left Hand, ſhew the length of the Shadow, and the laſt Figure, remaining towards the Right Hand, will tell you how much the Shadow is above ſo many even Parts, every 100 Part being divided into 10.

Thirdly, But if the Staff be divided into 10 equal Parts, then the former Figure, or Figures towards the Left-Hand, ſhews how many of thoſe Parts the Shadow of the Staff will yield at each Hour; and the two laſt Figures, towards the Right-Hand, being diſtinguiſhed from the former by a prick or Comma, will ſhew how much the Shadow is above ſo many even Parts, according to the Partition of every of thoſe 10 even Parts into 100.

But if upon your Staff of 10 equal Parts, you Subdivide each part into 10 more; then will the firſt Figure of the Fraction, next after the prick or Comma, point out how many of theſe Subdivided Parts the Shadow ſhall contain, over and above the whole Parts towards the Left-Hand. But to illuſtrate, and make this more clear, I ſhall add the following Examples.

The Use of the following Table.

Seek the place of the Sun in the first or second Column, towards the Left-Hand; and having divided your Staff into 10 equal Parts, (as before was taught) set it upright in some plain level place where the Sun doth shine, and then measure with your Staff, how many parts the shadow thereof contains, which find out in the Table right against the Sun's place, and in the same Column over head, you have the Hour of the Day.

I. Example, *Where the Staff is divided into* 1000 *Equal Parts.*

Suppose that upon the 10th of *March*, when the Sun enters *Aries*, I erect my Staff upon plain level Ground, and find the shadow thereof to contain 3130 Parts, (that is, three times the length of the Staff, and 130 Parts more) therefore seeking in the Table for the number of the said Parts, against 0 Deg. of ♈, I find the same in the seventh Column of the Table, under the Hours of 8 and 4; so that if the Observation had been in the Forenoon, it had been 8 a Clock, but in the Afternoon 4 a Clock.

II. Example, *Where the Staff is divided into* 100 *Equal Parts.*

But if your Staff be divided but into 100 Parts, and you find the shadow thereof to be 313 of the same Parts in length, seek out the same in the Table, (leaving out the last Figure towards the Right-Hand) and it giveth the Hour of the Day as before.

III. Example, *Where the Staff is divided into* 10 *Equal Parts.*

Lastly, If your Staff be divided but into 10 equal Parts, then the former Figures distinguished from the other two, towards the Right Hand, shew the length of the shadow, at the same time, to be 31 whole Parts, and 30 Parts of a 100, or 3 Parts of 10; that is, 3 times the length of my Staff, and one whole part, and something above a quarter of a part more.

And if, according to this Example, The same day I should set up my Staff, and find the shadow thereof to contain 62 whole Parts, and 67, which is about ⅔ of a part; the Table will shew me, that 'tis then 7 a Clock, if the Observation be in the Forenoon, or 5 if it be in the Afternoon.

But I need not add more here to Explain this matter, seeing the Table of it self is so easie, that what is already said, may suffice. And now having shewed my Surveyor, how he may find the just Hour of the day, at all times by the help of the Sun: I shall here also shew him, how to find the true Hour of the Night by the Moon, Planets, and Fixed Stars, when they are seen, after a most concise way, by Tables of Right and Oblique Ascensions in Time, for that purpose.

A

A TABLE ſhewing the True Hour of the Day, by a Plain Staff, Divided into 10, 100, or 1000 Equal Parts.

H.	Bet. No. / Aft. No.	12	11 / 1	10 / 2	9 / 3	8 / 4	7 / 5	6 / 6	5 / 7
♋ 0	0 ♋	5.54	6.05	7.50	9.88	13.49	19.25	29.97	57.20
25	5	5.57	6.08	7.54	9.92	13.54	19.34	30.19	57.99
20	10	5.62	6.13	7.59	9.98	13.65	19.47	30.47	59.02
15	15	5.75	6.25	7.70	10.12	13.83	19.82	31.24	61.85
10	20	5.88	6.39	7.86	10.30	14.08	20.20	32.07	65.22
5	25	6.09	6.60	8.08	10.56	14.41	20.81	33.47	71.15
♊ 0	0 ♌	6.32	6.83	8.32	10.84	14.81	21.48	35.07	78.61
25	5	6.61	7.12	8.63	11.21	15.32	22.40	37.34	90.58
20	10	6.92	7.44	8.98	11.61	15.91	23.42	40.01	107.79
15	15	7.30	7.82	9.38	12.12	16.63	24.76	43.63	138.38
10	20	7.71	8.23	9.83	12.67	17.43	26.26	48.08	196.27
5	25	8.18	8.72	10.36	13.33	18.40	28.16	54.31	358.00
♉ 0	0 ♍	8.89	9.23	10.93	14.04	19.48	30.35	62.32	864.00
25	5	9.27	9.83	11.59	14.88	20.78	33.16	74.29	
20	10	9.88	10.46	12.31	15.80	22.25	36.47	92.18	
15	15	10.57	11.18	13.12	16.87	24.00	40.74	121.85	
10	20	11.32	11.96	14.02	18.06	26.05	46.06	181.71	
5	25	12.14	12.82	15.01	19.43	28.45	53.13	363.69	
♈ 0	0 ♎	13.03	13.75	16.12	20.96	31.30	62.67		
25	5	14.01	14.78	17.35	22.73	34.72	76.30		
20	10	15.09	15.92	18.73	24.75	38.95	97.32		
15	15	16.26	17.18	20.26	27.08	44.11	113.00		
10	20	17.57	18.56	21.09	29.80	50.81	209.46		
5	25	18.95	20.06	23.88	32.90	59.23			
♓ 0	0 ♏	20.52	21.74	26.07	36.64	70.85			
25	5	22.15	23.52	28.40	40.81	86.21			
20	10	23.96	25.52	31.11	45.99	109.88			
15	15	25.84	27.57	33.94	51.78	145.13			
10	20	27.95	29.89	37.13	58.91	208.15			
5	25	30.05	32.14	40.50	66.78	343.68			
♒ 0	0 ♐	32.10	34.61	44.04	76.00	828.43			
25	5	34.08	36.81	47.62	86.32				
20	10	36.00	39.14	51.09	97.18				
15	15	37.63	40.87	54.18	107.97				
10	20	39.09	42.52	56.58	117.25				
5	25	39.71	43.26	58.25	123.84				
♑ 0	0 ♑	40.11	43.72	59.00	126.36				

PROB. VIII.

How to find the exact Time of the Planets and Fixed Stars, Rising, Southing, and Setting, by the following Tables; And First,

Of their Southing.

THE Estimate Time of a Planet or Fixed Stars, Rising, Southing or Setting may be nearly known by their distance from the Sun, which known, get the place of the Moon or Star to that time, with Latitude, and also the place of the Sun for that time also, then enter the Table of Right Ascensions, with the Longitude of the Planet or Star under its Latitude, (if it have any) and in the Angle of Meeting is the R A in Time, which write down, and likewise enter the said Table with the Sun's place, under o Latitude, (for the Sun is always in the Ecliptick Line) and take out his R A also, which Substract from the R A of the Star or Planet, (which increased by 24 Hours, if need require) and the Remainder is the Hour and Minute of the Planet or Stars Culminating, or coming to the South.

EXAMPLE

March 1. 1696. It is required to find the Time of *Jupiter's* coming to the South for the Night following, (we take their Places for Midnight, because they are nearly in opposition) the Longit. of ♃ is 22° 00′, ♍ with 1° 15′ N. Lat. and the Sun in 22° 30′ ♓, Hence

	H.	M.
R A of ♃ in time, 24 hours added) is	35	33
R A of ☉ in time, (Substract	23	32
♃ South, at 1 Minute after Midnight	12	01

This being both so plain and easie, that more Examples are needless, for the same Method is to be observed, in finding the Southing of the Moon and Fixed Stars.

Of the Rising of the Planets and Fixed Stars.

Enter the Table of Oblique Ascensions, with the Sign and Degree of the Star or Planet's place in respect of Latitude, and take out his Oblique Ascension agreeing thereto; enter the Table also with the Sign and Degree of the Sun's place, and take out his Oblique Ascension also, which Substracted from the Oblique Ascension of the Star, and to the Remainder, add the time of Sun Rising for that Day, the sum (Substracting 12 Hours if it exceed 12) is the true time of his Rising that Night.

EXAMPLE.

EXAMPLE I.

Of *Jupiter's* Rising the first day of *March* 1696. as followeth.

		H.	M.
The O A of ♃ in Time, (24 Hours add.)		35	09
The O A of ☉ in Time, Substract.		23	48
	Remainder	11	21
Time of Sun Rising, Add		6	19
	Sum	17	40
	Substract	12	00
Hence ♃ Rises, 40′ past 5 that Night.		5	40

Otherways by the same Tables: From the O A of the Planet or Star, Substract the Sun's R A, and if the Remainder exceed six Hours, Substract six Hours from it; and if it happen to be less than 6 Hours, add thereunto 9 Hours; this Sum or Difference is the true time of the Star or Planet's Rising required, as in the last Example.

EXAMPLE II.

		H.	M.
The O A of ♃ in Time, (24 hours add.)		35	09
R A of ☉ in time, Substract.		23	29
	Difference	11	40
	Substract	6	40
Time of *Jupiter's* Rising as before.		5	40

Thus is the Work abbreviated, and made both easie and practicable, observe the same Method in computing the Rising of the Moon, Fixed Stars, and other Planets.

Of the Setting of the Planets and Fixed Stars.

To find the Time of the Moon, Planets, and Fixed Stars Setting, the Oblique Descension is required, which is obtained by Entring the Table of Oblique Ascensions, with the opposite Sign and Degree, and under the Latitude of a contrary Denomination, and in the Angle of meeting is the O D of the Star or Planet; enter the Table also with the opposite Sign and Degree of the Sun's place, which gives his O D also under o Latitude, which Substracted from the O D of the Star or Planet, and the Remainder added to the time of the Sun's Setting for the same day, the Sum is the true time of the Star or Planet's Setting; as we shall Exemplifie here in *Jupiter* also, the same day that is before Exemplified both in his Southing and Rising, *viz.* The first of *March* 1696.

EXAM-

EXAMPLE I.

	H.	M.
The O D of ♃ in Time.	23	56
The O D of ☉ in Time.	11	18
Remains	12	38
Time of Sun Setting, Add	5	44
Sum	18	22
Substract	12	00
Hence, ♃ sets, 22′ past 6 next morning	6	22

We shall (as in the Rising) Exemplifie this, an easier and readier way from the Tables, as followeth.

EXAMPLE II.

	H.	M.
The O D of ♃ in Time.	23	56
The R A of ☉ in Time.	11	34
Remains	12	22
Substract	6	00
Time of *Jupiter*'s Setting as before.	6	22

Observe the same Method in Calculating the Setting of the ☽, and Fixed Stars: And for the obtaining the true Places of the Fixed Stars both in Longitude and Latitude, I have here Exhibited a Table of some eminent fixed Stars that are near the Ecliptick,

A TABLE of Ten of the Fixed Star's Places both in Longitude and Latitude, Rectified to the Year 1693.

Nomina Stellarum.	Longitude. S	°	′	Latitude. °	′	
The Pleiades, or Seven Stars.	♉	25	42	4	0	N
Aldebaran, or the Bull's Eye.	♊	5	30	5	31	S
Precepe.	♌	3	4	1	14	N
North Asellus.	♌	3	15	3	8	N
South Asellus.	♌	4	26	0	4	N
Cor Leonis.	♌	25	35	0	26	N
Virgin's Spic.	♎	19	34	1	59	S
South Ballance.	♏	10	49	0	26	N
Cor ♏, Antares.	♐	5	31	4	27	S
Australes.	♑	29	50	4	41	N

and Rectified their places to the year 1693. which may serve for this next Century, without sensible Errour.

A TABLE

A TABLE of Right Ascensions in Time, to Five Degrees of North and South Latitude.

	North Latitude. ♈.												South Latitude. ♈.									
Degr.	5		4		3		2		1		0		1		2		3		4		5	
	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'
0	0	8	0	6	0	5	0	3	0	2	0	0	23	58	23	57	23	55	23	54	23	52
1	0	12	0	10	0	8	0	7	0	5	0	4	0	2	0	1	23	59	23	57	23	56
2	0	15	0	14	0	12	0	10	0	9	0	7	0	6	0	4	0	3	0	1	23	59
3	0	19	0	17	0	16	0	14	0	13	0	11	0	9	0	8	0	6	0	5	0	3
4	0	23	0	21	0	19	0	18	0	16	0	13	0	13	0	12	0	10	0	8	0	7
5	0	26	0	25	0	23	0	21	0	20	0	18	0	17	0	16	0	14	0	12	0	10
6	0	30	0	28	0	27	0	25	0	24	0	22	0	20	0	19	0	17	0	16	0	14
7	0	34	0	32	0	30	0	29	0	27	0	26	0	24	0	23	0	21	0	19	0	18
8	0	37	0	36	0	34	0	33	0	31	0	29	0	28	0	26	0	25	0	23	0	21
9	0	41	0	39	0	38	0	36	0	35	0	33	0	31	0	30	0	28	0	27	0	25
10	0	45	0	43	0	42	0	40	0	38	0	37	0	55	0	34	0	32	0	30	0	29
11	0	48	0	47	0	45	0	44	0	42	0	40	0	39	0	37	0	36	0	34	0	32
12	0	52	0	51	0	49	0	47	0	46	0	44	0	43	0	41	0	39	0	38	0	36
13	0	56	0	54	0	53	0	51	0	49	0	48	0	46	0	44	0	43	0	41	0	40
14	0	59	0	58	0	56	0	55	0	53	0	52	0	50	0	48	0	47	0	45	0	44
15	1	3	1	1	1	0	0	58	0	57	0	55	0	54	0	52	0	51	0	49	0	48
16	1	7	1	5	1	4	1	2	1	0	0	59	0	57	0	56	0	54	0	53	0	51
17	1	10	1	9	1	7	1	6	1	4	1	3	1	1	1	0	0	58	0	56	0	55
18	1	14	1	12	1	11	1	9	1	8	1	6	1	5	1	3	1	2	1	[illegible]	0	59
19	1	18	1	16	1	15	1	13	1	12	1	10	1	9	1	7	1	5	1	4	1	2
20	1	21	1	20	1	18	1	17	1	15	1	14	1	12	1	11	1	9	1	8	1	6
21	1	25	1	24	1	22	1	20	1	19	1	18	1	16	1	14	1	13	1	11	1	10
22	1	29	1	27	1	26	1	24	1	23	1	21	1	20	1	18	1	17	1	15	1	14
23	1	32	1	31	1	30	1	28	1	27	1	26	1	24	1	22	1	21	1	19	1	17
24	1	36	1	35	1	33	1	32	1	30	1	29	1	27	1	26	1	24	1	23	1	21
25	1	40	1	39	1	37	1	36	1	34	1	33	1	32	1	30	1	28	1	27	1	25
26	1	44	1	42	1	41	1	39	1	38	1	36	1	35	1	33	1	32	1	30	1	29
27	1	47	1	46	1	45	1	43	1	42	1	40	1	39	1	37	1	36	1	34	1	33
28	1	51	1	50	1	48	1	47	1	45	1	44	1	43	1	41	1	40	1	38	1	37
29	1	55	1	53	1	52	1	51	1	49	1	48	1	46	1	45	1	43	1	42	1	40
30	1	59	1	57	1	56	1	55	1	53	1	52	1	50	1	49	1	47	1	46	1	44

A TABLE of Right Ascensions in Time, to Five Degrees of North and South Latitude.

North Latitude. ♉. South Latitude. ♉.

Degr.	5 h	5 '	4 h	4 '	3 h	3 '	2 h	2 '	1 h	1 '	0 h	0 '	1 h	1 '	2 h	2 '	3 h	3 '	4 h	4 '	5 h	5 '
0	1	44	1	46	1	47	1	49	1	50	1	52	1	53	1	55	1	56	1	57	1	59
1	1	48	1	50	1	51	1	53	1	54	1	55	1	56	1	58	1	59	2	1	2	2
2	1	52	1	54	1	55	1	56	1	58	1	59	2	0	2	2	2	3	2	5	2	6
3	1	56	1	58	1	59	2	0	2	2	2	3	2	4	2	6	2	7	2	9	2	10
4	2	c	2	1	2	3	2	4	2	6	2	7	2	8	2	10	2	11	2	12	2	14
5	2	4	2	5	2	7	2	8	2	9	2	11	2	12	2	14	2	15	2	16	2	18
6	2	8	2	9	2	11	2	12	2	13	2	15	2	16	2	17	2	19	2	20	2	21
7	2	12	2	13	2	14	2	16	2	17	2	19	2	20	2	21	2	23	2	24	2	25
8	2	16	2	17	2	18	2	20	2	21	2	23	2	24	2	25	2	26	2	28	2	29
9	2	2c	2	21	2	22	2	24	2	25	2	26	2	28	2	29	2	30	2	32	2	33
10	2	24	2	25	2	26	2	28	2	29	2	30	2	32	2	33	2	34	2	35	2	37
11	2	28	2	29	2	30	2	32	2	33	2	34	2	35	2	37	2	38	2	39	2	41
12	2	32	2	33	2	34	2	36	2	37	2	38	2	39	2	41	2	42	2	43	2	44
13	2	36	2	37	2	38	2	40	2	41	2	42	2	43	2	45	2	46	2	47	2	48
14	2	40	2	41	2	42	2	44	2	45	2	46	2	47	2	49	2	50	2	51	2	52
15	2	44	2	45	2	46	2	48	2	49	2	50	2	51	2	53	2	54	2	55	2	56
16	2	48	2	49	2	50	2	52	2	53	2	54	2	55	2	56	2	58	2	59	3	0
17	2	52	2	53	2	54	2	56	2	57	2	58	2	59	3	0	3	2	3	3	3	4
18	2	56	2	57	2	59	3	0	3	1	3	2	3	3	3	4	3	6	3	7	3	8
19	3	c	3	1	3	3	3	4	3	5	3	6	3	7	3	8	3	10	3	11	3	12
20	3	4	3	6	3	7	3	8	3	9	3	10	3	11	3	12	3	14	3	15	3	16
21	3	8	3	10	3	11	3	12	3	13	3	14	3	15	3	16	3	16	3	19	3	20
22	3	12	3	14	3	13	3	16	3	17	3	18	3	19	3	20	3	22	3	23	3	24
23	3	17	3	18	3	19	3	20	3	21	3	22	3	23	3	24	3	26	3	27	3	28
24	3	21	3	22	3	23	3	24	3	25	3	26	3	27	3	28	3	30	3	31	3	32
25	3	25	3	26	3	27	3	28	3	29	3	30	3	31	3	33	3	34	3	35	3	36
26	3	29	3	31	3	32	3	33	3	34	3	35	3	36	3	37	3	38	3	39	3	40
27	3	34	3	35	3	36	3	37	3	38	3	39	3	40	3	41	3	42	3	43	3	44
28	3	38	3	39	3	40	3	41	3	42	3	43	3	44	3	45	3	46	3	47	3	48
29	3	42	3	43	3	44	3	45	3	46	3	47	3	48	3	49	3	50	3	51	3	52
30	3	46	3	47	3	48	3	49	3	50	3	51	3	52	3	53	3	54	3	55	3	56

A TABLE of Right Afcenfions in Time, to Five Degrees of North and South Latitude.

	North Latitude. ♊.												South Latitude. ♊.									
Degr.	5		4		3		2		1		0		1		2		3		4		5	
	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'
0	3	46	3	47	3	48	3	49	3	50	3	51	3	52	3	53	3	54	3	55	3	36
1	3	52	3	52	3	53	3	53	3	54	3	55	3	56	3	57	3	58	3	59	4	0
2	3	55	3	56	3	57	3	58	3	59	4	0	4	0	4	1	4	2	4	3	4	4
3	3	59	4	0	4	1	4	2	4	3	4	4	4	5	4	5	4	6	4	7	4	8
4	4	4	4	5	4	5	4	6	4	7	4	8	4	9	4	10	4	10	4	11	4	12
5	4	8	4	9	4	10	4	10	4	11	4	12	4	13	4	14	4	14	4	15	4	16
6	4	12	4	13	4	14	4	15	4	15	4	16	4	17	4	18	4	19	4	19	4	20
7	4	17	4	18	4	18	4	19	4	20	4	21	4	21	4	22	4	23	4	24	4	24
8	4	21	4	22	4	23	4	23	4	24	4	25	4	25	4	26	4	27	4	28	4	28
9	4	26	4	26	4	27	4	28	4	28	4	29	4	30	4	30	4	31	4	32	4	32
10	4	30	4	31	4	31	4	32	4	32	4	33	4	34	4	35	4	35	4	36	4	36
11	4	34	4	35	4	36	4	36	4	36	4	38	5	38	4	39	4	39	4	40	4	41
12	4	39	4	40	4	40	4	40	4	41	4	42	4	43	4	43	4	44	4	44	4	45
13	4	43	4	44	4	45	4	45	4	45	4	46	4	47	4	47	4	48	4	48	4	49
14	4	48	4	48	4	49	4	49	4	50	4	51	4	51	4	52	4	52	4	53	4	53
15	4	52	4	52	4	53	4	54	4	54	4	55	4	55	4	56	4	56	4	57	4	57
16	4	57	4	57	4	58	4	58	4	58	4	59	5	0	5	0	5	0	5	1	5	1
17	5	1	5	2	5	2	5	2	5	2	5	3	5	4	5	4	5	5	5	5	5	6
18	5	6	5	6	5	6	5	6	5	7	5	8	5	8	5	9	5	9	5	9	5	10
19	5	10	5	10	5	11	5	11	5	12	5	12	5	12	5	13	5	13	5	14	5	14
20	5	15	5	15	5	15	5	15	5	15	5	16	5	17	5	17	5	17	5	18	5	18
21	5	19	5	19	5	19	5	19	5	20	5	21	5	21	5	21	5	22	5	22	5	22
22	5	23	5	24	5	24	5	24	5	24	5	25	5	25	5	26	5	26	5	26	5	26
23	5	28	5	28	5	28	5	28	5	28	5	29	5	29	5	30	5	30	5	30	5	31
24	5	32	5	33	5	33	5	33	5	33	5	34	5	34	5	34	5	34	5	35	5	35
25	5	37	5	37	5	37	5	37	5	37	5	38	5	38	5	38	5	39	5	39	5	40
26	5	41	5	42	5	42	5	42	5	42	5	43	5	43	5	43	5	43	5	43	5	43
27	5	45	5	46	5	46	5	46	5	46	5	47	5	47	5	47	5	47	5	47	5	48
28	5	50	5	50	5	50	5	50	5	50	5	51	5	52	5	52	5	52	5	53	5	53
29	5	54	5	54	5	54	5	54	5	55	5	56	5	56	5	56	5	56	5	56	5	56
30	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0

A TABLE of Right Ascensions in Time, to Five Degrees of North and South Latitude.

Degr.	North Latitude. ♋.												South Latitude. ♋.									
	5		4		3		2		1		0		1		2		3		4		5	
	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'
0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0
1	6	5	6	5	6	4	6	4	6	4	6	4	6	4	6	4	6	4	6	4	6	4
2	6	9	6	9	6	9	6	9	6	9	6	9	6	9	6	9	6	9	6	9	6	8
3	6	14	6	14	6	13	6	13	6	13	6	13	6	13	6	13	6	13	6	13	6	13
4	6	18	6	18	6	18	6	18	6	18	6	17	6	17	6	17	6	17	6	17	6	17
5	6	23	6	23	6	22	6	22	6	22	6	22	6	22	6	22	6	21	6	21	6	21
6	6	27	6	27	6	27	6	26	6	26	6	26	6	26	6	26	6	26	6	25	6	25
7	6	32	6	31	6	31	6	31	6	31	6	31	6	30	6	30	6	30	6	29	6	29
8	6	36	6	36	6	36	6	35	6	35	6	35	6	35	6	34	6	34	6	34	6	34
9	6	40	6	40	6	40	6	40	6	39	6	39	6	39	6	39	6	38	6	38	6	38
10	6	45	6	45	6	45	6	44	6	44	6	44	6	43	6	43	6	43	6	42	6	42
11	6	50	6	49	6	49	6	49	6	48	6	48	6	47	6	47	6	47	6	46	6	46
12	6	54	6	54	6	53	6	53	6	53	6	52	6	52	6	51	6	51	6	51	6	51
13	6	59	6	58	6	58	6	57	6	57	6	56	6	56	6	56	6	55	6	55	6	54
14	7	3	7	3	7	2	7	2	7	1	7	1	7	0	7	0	6	59	6	59	6	59
15	7	8	7	7	7	7	7	6	7	6	7	5	7	5	7	4	7	4	7	3	7	3
16	7	12	7	12	7	11	7	10	7	10	7	9	7	9	7	8	7	8	7	8	7	7
17	7	17	7	16	7	13	7	15	7	14	7	14	7	13	7	13	7	12	7	12	7	11
18	7	21	7	20	7	20	7	19	7	19	7	18	7	17	7	17	7	16	7	16	7	15
19	7	25	7	25	7	24	7	23	7	23	7	22	7	22	7	21	7	21	7	20	7	19
20	7	30	7	29	7	29	7	28	7	27	7	27	7	26	7	25	7	25	7	24	7	23
21	7	34	7	34	7	33	7	32	7	31	7	31	7	30	7	30	7	29	7	28	7	28
22	7	38	7	37	7	37	7	36	7	36	7	35	7	34	7	34	7	33	7	32	7	32
23	7	43	7	42	7	42	7	41	7	40	7	39	7	39	7	38	7	37	7	36	7	36
24	7	47	7	47	7	46	7	45	7	44	7	44	7	43	7	42	7	41	7	41	7	40
25	7	52	7	52	7	51	7	50	7	49	7	48	7	47	7	46	7	46	7	45	7	44
26	7	56	7	55	7	55	7	54	7	53	7	52	7	51	7	50	7	50	7	49	7	48
27	8	1	8	0	7	59	7	58	7	57	7	56	7	55	7	55	7	54	7	53	7	52
28	8	5	8	4	8	3	8	2	8	1	8	0	8	0	7	59	7	58	7	57	7	56
29	8	9	8	8	8	7	8	6	8	5	8	5	8	4	7	3	8	2	8	1	8	0
30	8	13	8	12	8	11	8	11	8	10	8	9	8	8	7	7	8	6	8	5	8	4

A TABLE of Right Ascensions in Time, to Five Degrees of North and South Latitude.

North Latitude. ♌ South Latitude. ♌

Degr.	5		4		3		2		1		0		1		2		3		4		5	
	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'
0	8	13	8	12	8	11	8	11	8	10	8	9	8	8	8	7	8	6	8	5	8	4
1	8	18	8	17	8	16	8	15	8	14	8	13	8	12	8	11	8	10	8	9	8	8
2	8	22	8	21	8	20	8	19	8	18	8	17	8	16	8	15	8	14	8	13	8	12
3	8	26	8	25	8	24	8	23	8	22	8	21	8	20	8	19	8	18	8	17	8	16
4	8	30	8	29	8	28	8	27	8	26	8	25	8	24	8	23	8	22	8	21	8	20
5	8	35	8	34	8	33	8	32	8	31	8	29	8	28	8	27	8	26	8	25	8	24
6	8	39	8	38	8	37	8	36	8	35	8	34	8	33	8	31	8	30	8	29	8	28
7	8	43	8	42	8	41	8	40	8	39	8	38	8	37	8	36	8	34	8	33	8	32
8	8	47	8	46	8	45	8	44	8	43	8	42	8	41	8	40	8	38	8	37	8	36
9	8	52	8	50	8	49	8	48	8	47	8	46	8	45	8	44	8	42	8	41	8	40
10	8	56	8	54	8	53	8	52	8	51	8	50	8	49	8	48	8	46	8	45	8	44
11	9	0	8	59	8	57	8	56	8	55	8	54	8	53	8	52	8	50	8	49	8	48
12	9	4	8	3	9	1	9	0	8	59	8	58	8	57	8	56	8	54	8	53	8	52
13	9	8	9	7	9	5	9	4	9	3	9	2	9	1	9	0	8	58	8	57	8	56
14	9	12	9	11	9	10	9	8	9	7	9	6	9	5	9	4	9	2	9	1	9	0
15	9	16	9	15	9	14	9	12	9	11	9	10	9	9	9	7	9	6	9	5	9	4
16	9	20	9	19	9	18	9	16	9	15	9	14	9	13	9	11	9	10	9	9	9	8
17	9	24	9	23	9	22	9	20	9	19	9	18	9	17	9	15	9	14	9	13	9	12
18	9	28	9	27	9	26	9	24	9	23	9	22	9	21	9	19	9	18	9	17	9	16
19	9	32	9	31	9	30	9	28	9	27	9	26	9	24	9	23	9	22	9	21	9	20
20	9	36	9	35	9	34	9	32	9	31	9	30	9	28	9	27	9	26	9	25	9	23
21	9	40	9	39	9	38	9	36	9	35	9	34	9	32	9	31	9	30	9	29	9	27
22	9	44	9	43	9	42	9	40	9	39	9	38	9	36	9	35	9	34	9	32	9	31
23	9	48	9	47	9	46	9	44	9	43	9	41	9	40	9	39	9	37	9	36	9	35
24	9	52	9	51	9	49	9	48	9	47	9	45	9	44	9	43	9	41	9	40	9	39
25	9	56	9	55	9	53	9	52	9	51	9	49	9	48	9	46	9	45	9	44	9	42
26	10	0	9	59	9	57	9	56	9	54	9	53	9	52	9	50	9	49	9	48	9	46
27	10	4	10	3	10	1	10	0	9	58	9	57	9	56	9	54	9	53	9	51	9	50
28	10	8	10	6	10	5	10	4	10	2	10	1	9	59	9	58	6	57	9	55	9	54
29	10	12	10	10	10	9	10	7	10	6	10	5	10	3	10	2	10	0	9	59	9	57
30	10	16	10	14	10	13	10	11	10	10	10	8	10	7	10	6	10	4	10	3	10	1

A TABLE of Right Ascensions in Time, to Five Degrees of North and South Latitude.

Degr.	North Latitude. ♍.												South Latitude. ♍.									
	5		4		3		2		1		0		1		2		3		4		5	
	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'
0	10	16	10	14	10	13	10	11	10	10	10	8	10	7	10	6	10	4	10	3	10	1
1	10	20	10	18	10	17	10	15	10	14	10	12	10	11	10	9	10	8	10	7	10	5
2	10	23	10	22	10	20	10	19	10	18	10	16	10	14	10	13	10	12	10	10	10	9
3	10	27	10	26	10	24	10	23	10	21	10	20	10	18	10	17	10	15	10	14	10	13
4	10	31	10	30	10	28	10	27	10	25	10	24	10	22	10	21	10	19	10	18	10	16
5	10	35	10	33	10	32	10	30	10	29	10	27	10	26	10	24	10	23	10	21	10	20
6	10	39	10	37	10	36	10	34	10	33	10	31	10	30	10	28	10	27	10	25	10	24
7	10	43	10	41	10	39	10	38	10	36	10	35	10	33	10	32	10	30	10	29	10	27
8	10	46	10	45	10	43	10	42	10	40	10	39	10	37	10	36	10	34	10	33	10	31
9	10	50	10	49	10	47	10	45	10	44	10	42	10	41	10	39	10	38	10	36	10	35
10	10	54	10	52	10	51	10	49	10	48	10	46	10	45	10	43	10	42	10	40	10	39
11	10	58	10	56	10	55	10	53	10	51	10	50	10	48	10	47	10	45	10	44	10	42
12	11	1	11	0	10	58	10	57	10	55	10	54	10	52	10	51	10	49	10	48	10	46
13	11	5	11	4	11	2	11	1	10	59	10	57	10	56	10	54	10	53	10	51	10	50
14	11	9	11	7	11	6	11	4	11	3	11	1	11	0	10	58	10	56	10	55	10	53
15	11	13	11	11	11	9	11	8	11	6	11	5	11	3	11	2	11	0	10	59	10	57
16	11	16	11	15	11	13	11	12	11	10	11	8	11	7	11	5	11	4	11	2	11	1
17	11	20	11	18	11	17	11	15	11	14	11	12	11	11	11	9	11	7	11	6	11	4
18	11	24	11	22	11	21	11	18	11	17	11	16	11	14	11	13	11	11	11	10	11	8
19	11	28	11	26	11	24	11	23	11	21	11	20	11	18	11	16	11	15	11	13	11	12
20	11	32	11	30	11	28	11	27	11	25	11	23	11	22	11	20	11	19	11	17	11	16
21	11	35	11	33	11	32	11	30	11	29	11	27	11	25	11	24	11	22	11	21	11	19
22	11	39	11	37	11	35	11	34	11	32	11	31	11	29	11	27	11	26	11	24	11	23
23	11	42	11	41	11	39	11	37	11	36	11	34	11	33	11	31	11	29	11	28	11	26
24	11	46	11	44	11	43	11	41	11	40	11	38	11	36	11	35	11	33	11	32	11	30
25	11	50	11	48	11	47	11	45	11	43	11	42	11	40	11	39	11	37	11	35	11	34
26	11	53	11	52	11	50	11	48	11	47	11	46	11	44	11	42	11	41	11	39	11	37
27	11	57	11	55	11	54	11	52	11	51	11	49	11	47	11	46	11	44	11	43	11	41
28	11	1	11	59	11	57	11	56	11	54	11	53	11	51	11	49	11	48	11	46	11	45
29	11	4	12	3	12	1	11	59	11	58	11	56	11	55	11	53	11	52	11	50	11	48
30	11	8	12	6	12	5	12	3	12	1	12	0	11	58	11	57	11	55	11	54	11	52

A TABLE of Right Ascensions in Time, to Five Degrees of North and South Latitude.

North Latitude. ♎. South Latitude. ♎.

Degr.	5		4		3		2		1		0		1		2		3		4		5	
	h	′	h	′	h	′	h	′	h	′	h	′	h	′	h	′	h	′	h	′	h	′
0	12	8	12	6	12	5	12	3	12	2	12	0	11	58	11	57	11	55	11	54	11	52
1	12	12	12	10	12	8	12	7	12	5	12	4	12	2	12	1	11	59	11	57	11	56
2	12	15	12	14	12	12	12	10	12	9	12	7	12	6	12	4	12	3	12	[illegible]	11	59
3	12	19	12	17	12	16	12	14	12	13	12	11	12	9	12	8	12	6	12	5	12	3
4	12	23	12	21	12	19	12	18	12	16	12	15	12	13	12	12	12	10	12	8	12	7
5	12	26	12	25	12	23	12	21	12	20	12	18	12	17	12	15	12	14	12	12	12	10
6	12	30	12	28	12	27	12	25	12	24	12	22	12	20	12	19	12	17	12	16	12	14
7	12	34	12	32	12	30	12	29	12	27	12	26	12	24	12	23	12	21	12	19	12	18
8	12	37	12	36	12	34	12	33	12	31	12	29	12	28	12	26	12	25	12	23	12	21
9	12	41	12	39	12	38	12	36	12	35	12	33	12	31	12	30	12	28	12	27	12	25
10	12	45	12	43	12	42	12	40	12	38	12	37	12	35	12	34	12	32	12	30	12	29
11	12	48	12	47	12	45	12	44	12	42	12	40	12	39	12	37	12	36	12	34	12	32
12	12	52	12	51	12	49	12	47	12	46	12	44	12	43	12	41	12	39	12	38	12	36
13	12	56	12	54	12	53	12	51	12	49	12	48	12	46	12	44	12	43	12	41	12	40
14	12	59	12	58	12	56	12	55	12	53	12	52	12	50	12	48	12	47	12	45	12	44
15	13	3	13	1	13	0	12	58	12	57	12	55	12	54	12	52	12	51	12	49	12	48
16	13	7	13	5	13	4	13	2	13	0	12	59	12	57	12	56	12	54	12	53	12	52
17	13	10	13	9	13	7	13	6	13	4	13	3	13	1	13	0	12	58	12	56	12	55
18	13	14	13	12	13	11	13	9	13	8	13	6	13	5	13	3	13	2	13	0	12	59
19	13	18	13	16	13	15	13	13	13	12	13	10	13	9	13	7	13	5	13	4	13	2
20	13	21	13	20	13	18	13	17	13	15	13	14	13	12	13	11	13	9	13	8	13	6
21	13	25	13	24	13	22	13	20	13	19	13	18	13	16	13	14	13	13	13	11	13	10
22	13	29	13	27	13	26	13	24	13	23	13	21	13	20	13	18	13	17	13	15	13	14
23	13	32	13	31	13	30	13	28	13	27	13	26	13	24	13	23	13	21	13	19	13	17
24	13	36	13	35	13	33	13	32	13	30	13	29	13	27	13	26	13	24	13	23	13	21
25	13	40	13	39	13	37	13	36	13	34	13	33	13	32	13	30	13	28	13	27	13	25
26	13	44	13	42	13	41	13	39	13	38	13	36	13	35	13	33	13	32	13	30	13	29
27	13	47	13	46	13	45	13	43	13	42	13	40	13	39	13	37	13	36	13	34	13	33
28	13	51	13	50	13	48	13	47	13	45	13	44	13	43	13	41	13	40	13	38	13	37
29	13	55	13	53	13	52	13	51	13	49	13	48	13	46	13	45	13	43	13	42	13	40
30	13	59	13	57	13	56	13	55	13	54	13	52	13	50	13	49	13	47	13	46	13	44

A TABLE of Right Afcenfions in Time, to Five Degrees of North and South Latitude.

	North Latitude. ♏.												South Latitude. ♏.									
Degr.	5		4		3		2		1		0		1		2		3		4		5	
	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'
0	13	59	13	57	13	56	13	55	13	53	13	52	13	50	13	49	13	47	13	46	13	44
1	14	2	14	1	13	59	13	58	13	56	13	55	13	54	13	53	13	51	13	50	13	48
2	14	6	14	5	14	3	14	2	14	0	13	59	13	58	13	56	13	55	13	54	13	52
3	14	10	14	9	14	7	14	6	14	4	14	3	14	2	14	0	13	59	13	58	13	56
4	14	14	14	12	14	11	14	10	14	8	14	7	14	6	14	4	14	3	14	1	14	0
5	14	18	14	16	14	15	14	14	14	12	14	11	14	9	14	8	14	7	14	5	14	4
6	14	21	14	20	14	19	14	17	14	16	14	15	14	13	14	12	14	11	14	9	14	8
7	14	25	14	24	14	23	14	21	14	20	14	19	14	17	14	16	14	14	14	13	14	12
8	14	29	14	28	14	26	14	25	14	24	14	23	14	21	14	20	14	18	14	17	14	16
9	14	33	14	32	14	30	14	29	14	28	14	26	14	25	14	24	14	22	14	21	14	20
10	14	37	14	35	14	34	14	33	14	32	14	30	14	29	14	28	14	26	14	25	14	24
11	14	41	14	39	14	38	14	37	14	35	14	34	14	33	14	32	14	30	14	29	14	28
12	14	44	14	43	14	42	14	41	14	39	14	38	14	37	14	36	14	34	14	33	14	32
13	14	48	14	47	14	46	14	45	14	43	14	42	14	41	14	40	14	38	14	37	14	36
14	14	52	14	51	14	50	14	49	14	47	14	46	14	45	14	44	14	42	14	41	14	40
15	14	56	14	55	14	54	14	53	14	51	14	50	14	49	14	48	14	46	14	45	14	44
16	15	0	14	59	14	58	14	56	14	55	14	54	14	52	14	52	14	50	14	49	14	48
17	15	4	15	3	15	2	15	0	14	59	14	58	14	57	14	56	14	54	14	53	14	52
18	15	8	15	7	15	6	15	4	15	3	15	2	15	1	15	0	14	59	14	57	14	56
19	15	12	15	11	15	10	15	8	15	7	15	6	15	5	15	4	15	3	15	1	15	0
20	15	16	15	15	15	14	15	12	15	12	15	10	15	9	15	8	15	7	15	6	15	4
21	15	20	15	19	15	18	15	16	15	15	15	14	15	13	15	12	15	11	15	10	15	8
22	15	24	15	23	15	22	15	20	15	19	15	18	15	17	15	16	15	15	15	14	15	13
23	15	28	15	27	15	26	15	24	15	23	15	22	15	21	15	20	15	19	15	18	15	17
24	15	32	15	31	15	30	15	28	15	27	15	26	15	25	15	24	15	23	15	22	15	21
25	15	36	15	35	15	34	15	33	15	31	15	30	15	29	15	28	15	27	15	26	15	25
26	15	40	15	39	15	38	15	37	15	35	15	35	15	34	15	33	15	32	15	31	15	29
27	15	44	15	43	15	42	15	41	15	40	15	39	15	38	15	37	15	36	15	35	15	34
28	15	48	15	47	15	46	15	45	15	44	15	43	15	42	15	41	15	40	15	39	15	38
29	15	52	15	51	15	50	15	49	15	48	15	47	15	46	15	45	15	44	15	43	15	42
30	15	56	15	55	15	54	15	53	15	52	15	51	15	50	15	49	15	48	15	47	15	46

A TABLE of Right Aſcenſions in Time, to Five Degrees of North and South Latitude.

	North Latitude. ♐.												South Latitude. ♐.									
Degr.	5		4		3		2		1		0		1		2		3		4		5	
	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'
0	15	56	15	55	15	54	15	53	15	52	15	51	15	50	15	49	15	48	15	47	15	46
1	16	0	15	59	15	58	15	57	15	56	15	55	15	54	15	53	15	53	15	52	15	52
2	16	4	16	3	16	2	16	1	16	0	16	0	15	59	15	58	15	57	15	56	15	55
3	16	8	16	7	16	6	16	5	16	4	16	4	16	3	16	2	16	1	16	0	15	59
4	16	12	16	11	16	10	16	10	16	9	16	8	16	7	16	6	16	5	16	4	16	4
5	16	16	16	15	16	14	16	14	16	13	16	12	16	11	16	10	16	10	16	9	16	8
6	16	20	16	19	16	19	16	18	16	17	16	16	16	15	16	15	16	14	16	13	16	12
7	16	24	16	24	16	23	16	22	16	21	16	21	16	20	16	19	16	18	16	18	16	17
8	16	28	16	28	16	27	16	26	16	25	16	25	16	24	16	23	16	23	16	22	16	21
9	16	32	16	32	16	31	16	30	16	30	16	29	16	28	16	28	16	27	16	26	16	26
10	16	36	16	36	16	35	16	35	16	34	16	33	16	32	16	32	16	31	16	31	16	30
11	16	41	16	40	16	39	16	39	16	38	16	38	16	37	16	36	16	36	16	35	16	34
12	16	45	16	44	16	44	16	43	16	43	16	42	16	41	16	40	16	40	16	39	16	39
13	16	49	16	48	16	48	16	47	16	47	16	46	16	45	16	45	16	45	16	44	16	43
14	16	53	16	52	16	52	16	52	16	51	16	51	16	50	16	49	16	49	16	48	16	48
15	16	57	16	57	16	56	16	56	16	55	16	55	16	54	16	54	16	53	16	53	16	52
16	17	1	17	1	17	0	17	0	17	0	16	59	16	58	16	58	16	58	16	57	16	57
17	17	6	17	5	17	5	17	4	17	4	17	3	17	3	17	2	17	2	17	2	17	1
18	17	10	17	9	17	9	17	9	17	8	17	8	17	8	17	7	17	7	17	6	17	6
19	17	14	17	14	17	13	17	13	17	12	17	12	17	12	17	11	17	11	17	11	17	10
20	17	18	17	18	17	17	17	17	17	17	17	16	17	16	17	15	17	15	17	15	17	15
21	17	22	17	22	17	22	17	21	17	21	17	21	17	20	17	19	17	19	17	19	17	19
22	17	26	17	26	17	26	17	26	17	25	17	25	17	24	17	24	17	24	17	24	17	23
23	17	31	17	30	17	30	17	30	17	30	17	29	17	28	17	28	17	28	17	28	17	28
24	17	35	17	35	17	34	17	34	17	34	17	34	17	33	17	33	17	33	17	33	17	32
25	17	40	17	39	17	39	17	38	17	38	17	38	17	37	17	37	17	37	17	37	17	37
26	17	43	17	43	17	43	17	43	17	43	17	43	17	42	17	42	17	42	17	42	17	41
27	17	48	17	47	17	47	17	47	17	47	17	47	17	46	17	46	17	46	17	46	17	45
28	17	53	17	53	17	52	17	52	17	52	17	51	17	50	17	50	17	50	17	50	17	50
29	17	56	17	56	17	56	17	56	17	56	17	56	17	55	17	54	17	54	17	54	17	54
30	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0

A TABLE of Right Ascensions in Time, to Five Degrees of North and South Latitude.

Degr.	North Latitude. ♑.												South Latitude. ♑.									
	5		4		3		2		1		0		1		2		3		4		5	
	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'
0	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0
1	18	4	18	4	18	4	18	4	18	4	18	4	18	4	18	4	18	4	18	5	18	5
2	18	8	18	9	18	9	18	9	18	9	18	9	18	9	18	9	18	9	18	9	18	9
3	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18	13	18	14	18	14
4	18	17	18	17	18	17	18	17	18	17	18	17	18	17	18	18	18	18	18	18	18	18
5	18	21	18	21	18	21	18	22	18	22	18	22	18	22	18	22	18	22	18	23	18	23
6	18	25	18	25	18	26	18	26	18	26	18	26	18	26	18	27	18	27	18	27	18	27
7	18	30	18	29	18	30	18	30	18	30	18	31	18	31	18	31	18	31	18	31	18	32
8	18	34	18	30	18	35	18	35	18	35	18	35	18	35	18	35	18	36	18	36	18	36
9	18	38	18	38	18	39	18	39	18	39	18	39	18	39	18	40	18	40	18	40	18	40
10	18	42	18	42	18	43	18	43	18	43	18	44	18	44	18	44	18	45	18	45	18	45
11	18	46	18	46	18	47	18	47	18	47	18	48	18	48	18	49	18	49	18	49	18	50
12	18	51	18	51	18	51	18	51	18	52	18	52	18	52	18	53	18	53	18	53	18	54
13	18	54	18	55	18	55	18	56	18	56	18	56	18	56	18	57	18	57	18	58	18	57
14	18	59	18	59	18	59	19	0	19	0	19	1	19	1	19	2	19	2	19	3	19	3
15	19	3	19	3	19	4	19	4	19	5	19	5	19	5	19	6	19	7	19	7	19	8
16	19	8	19	8	19	8	19	8	19	9	19	9	19	9	19	10	19	11	19	12	19	12
17	19	11	19	12	19	12	19	13	19	13	19	14	19	14	19	15	19	15	19	16	19	17
18	19	15	19	16	19	16	19	17	19	17	19	18	19	18	19	19	19	20	19	20	19	21
19	19	19	19	20	19	21	19	21	19	22	19	22	19	22	19	23	19	24	19	25	19	25
20	19	23	19	24	19	25	19	25	19	26	19	27	19	27	19	28	19	29	19	29	19	30
21	19	28	19	28	19	29	19	30	19	30	19	31	19	31	19	32	19	33	19	34	19	34
22	19	32	19	32	19	33	19	34	19	34	19	36	19	36	19	36	19	37	19	37	19	38
23	19	36	19	36	19	37	19	38	19	39	19	40	19	40	19	41	19	42	19	42	19	43
24	19	40	19	41	19	41	19	42	19	43	19	44	19	44	19	45	19	46	19	47	19	47
25	19	44	19	45	19	46	19	46	19	47	19	48	19	49	19	50	19	51	19	51	19	52
26	19	48	19	49	19	50	19	50	19	51	19	52	19	53	19	54	19	55	19	55	19	56
27	19	52	19	53	19	54	19	53	19	55	19	56	19	57	19	58	19	59	20	0	20	1
28	19	56	19	57	19	58	19	59	20	0	20	0	20	1	20	2	20	3	20	4	20	5
29	20	0	20	1	20	2	20	3	20	4	20	5	20	5	20	6	20	7	20	8	20	9
30	20	4	20	5	20	6	20	7	20	8	20	9	20	10	20	11	20	11	20	12	20	13

A TABLE of Right Aſcenſions in Time, to Five Degrees of North and South Latitude.

Degr.	North Latitude. ♒.												South Latitude. ♒.									
	5		4		3		2		1		0		1		2		3		4		5	
	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'
0	20	4	20	5	20	6	20	7	20	8	20	9	20	10	20	11	20	11	20	12	20	13
1	20	8	20	9	20	10	20	11	20	12	20	13	20	14	20	15	20	16	20	17	20	18
2	20	12	20	13	20	14	20	15	20	16	20	17	20	18	20	19	20	20	20	21	20	22
3	20	16	20	17	20	18	20	19	20	20	20	21	20	22	20	23	20	24	20	25	20	26
4	20	20	20	21	20	22	20	23	20	24	20	25	20	26	20	27	20	28	20	29	20	30
5	20	24	20	25	20	26	20	27	20	28	20	29	20	31	20	32	20	33	20	34	20	35
6	20	28	20	29	20	30	20	31	20	33	20	34	20	35	20	36	20	37	20	38	20	39
7	20	32	20	33	20	34	20	36	20	37	20	38	20	39	20	40	20	41	20	42	20	43
8	20	36	20	37	20	38	20	40	20	41	20	42	20	43	20	44	20	45	20	46	20	47
9	20	40	20	41	20	42	20	44	20	45	20	46	20	47	20	48	20	49	20	50	20	52
10	20	44	20	45	20	46	20	48	20	49	20	50	20	51	20	52	20	53	20	54	20	56
11	20	48	20	49	20	50	20	52	20	53	20	54	20	55	20	56	20	57	20	59	21	0
12	20	52	20	53	20	54	20	56	20	57	20	58	20	59	21	0	21	1	21	3	21	4
13	20	56	20	57	20	58	21	0	21	1	21	2	21	3	21	4	21	5	21	7	21	8
14	21	0	21	1	21	2	21	4	21	5	21	6	21	7	21	8	21	10	21	11	21	12
15	21	4	21	5	21	6	21	7	21	9	21	10	21	11	21	12	21	14	21	15	21	16
16	21	8	21	9	21	10	21	11	21	13	21	14	21	15	21	16	21	18	21	19	21	20
17	21	12	21	13	21	14	21	15	21	17	21	18	21	19	21	20	21	22	21	23	21	24
18	21	16	21	17	21	18	21	19	21	21	21	22	21	23	21	24	21	26	21	27	21	28
19	21	19	21	21	21	22	21	23	21	24	21	26	21	27	21	28	21	30	21	31	21	32
20	21	23	21	25	21	26	21	27	21	28	21	30	21	31	21	32	21	34	21	35	21	36
21	21	27	21	29	21	30	21	31	21	32	21	34	21	35	21	36	21	38	21	39	21	40
22	21	31	21	32	21	34	21	35	21	36	21	38	21	39	21	40	21	42	21	43	21	44
23	21	35	21	36	21	37	21	39	21	40	21	41	21	43	21	44	21	46	21	47	21	48
24	21	39	21	40	21	41	21	43	21	44	21	45	21	47	21	48	21	49	21	51	21	52
25	21	42	21	44	21	45	21	46	21	48	21	49	21	51	21	52	21	53	21	55	21	56
26	21	46	21	48	21	49	21	50	21	52	21	53	21	54	21	56	21	57	21	59	22	0
27	21	50	21	52	21	53	21	54	21	56	21	57	21	58	22	0	22	1	22	3	22	4
28	21	54	21	55	21	57	21	58	21	59	22	1	22	2	22	4	22	5	22	6	22	8
29	21	57	21	59	22	0	22	2	22	3	22	5	22	6	22	7	22	9	22	10	22	12
30	22	1	22	3	22	4	22	6	22	7	22	8	22	10	22	11	22	13	22	14	22	16

A TABLE of Right Afcenfions in Time, to Five Degrees of North and South Latitude.

	North Latitude. ♓.												South Latitude. ♓.									
Degr.	5		4		3		2		1		0		1		2		3		4		5	
	h	′	h	′	h	′	h	′	h	′	h	′	h	′	h	′	h	′	h	′	h	′
0	22	1	22	3	22	4	22	6	22	7	22	8	22	10	22	11	22	13	22	14	22	16
1	22	5	22	7	22	8	22	9	22	11	22	12	22	14	22	15	22	17	22	18	22	20
2	22	9	22	10	22	12	22	13	22	14	22	16	22	18	22	19	22	20	22	22	22	23
3	22	13	22	14	22	15	22	17	22	18	22	20	22	21	22	23	22	24	22	26	22	27
4	32	16	22	18	22	19	22	21	22	22	22	24	22	25	22	27	22	28	22	30	22	31
5	22	20	22	21	22	23	22	24	22	26	22	27	22	29	22	30	22	32	22	33	22	35
6	22	24	22	25	22	27	22	28	22	30	22	31	22	33	22	34	22	36	22	37	22	39
7	22	27	22	29	22	30	22	32	22	33	22	35	22	36	22	38	22	39	22	41	22	41
8	22	31	22	33	22	34	22	36	22	37	22	39	22	40	22	42	22	43	22	45	22	46
9	22	35	22	36	22	38	22	39	22	41	22	42	22	44	22	45	22	47	22	49	22	50
10	22	39	22	40	22	42	22	43	22	45	22	46	22	48	22	49	22	51	22	52	22	54
11	22	42	22	44	22	45	22	47	22	49	22	50	22	51	22	53	22	55	22	56	22	58
12	22	46	22	48	22	49	22	51	22	52	22	54	22	55	22	57	22	58	23	0	23	1
13	22	50	22	51	22	53	22	54	22	56	22	57	22	59	23	1	23	2	23	3	23	5
14	22	53	22	55	22	56	22	58	23	0	23	1	23	3	23	4	23	6	23	7	23	9
15	22	57	22	59	23	0	23	2	23	3	23	5	23	6	23	8	23	9	23	11	23	13
16	23	1	23	2	23	4	33	5	23	7	23	8	23	10	23	12	23	13	23	15	23	16
17	23	4	23	6	33	7	23	9	23	11	23	12	23	14	23	15	23	17	23	18	23	20
18	23	8	23	10	23	11	23	13	23	14	23	16	23	18	23	19	23	21	23	22	23	24
19	23	12	23	13	23	15	23	16	23	18	23	20	23	21	23	23	23	24	23	26	23	28
20	23	16	23	17	23	19	23	20	23	22	23	23	23	25	23	27	23	28	23	30	23	32
21	23	19	23	21	23	22	23	24	23	25	23	27	23	29	23	30	23	32	23	33	23	35
22	23	23	23	24	23	26	23	27	23	29	23	31	23	32	23	34	23	35	23	37	23	39
23	23	26	23	28	23	29	23	31	23	33	23	34	23	36	23	37	23	39	23	41	23	42
24	23	30	23	32	23	33	23	35	23	36	23	38	23	40	23	41	23	43	23	44	23	46
25	23	34	23	35	23	37	23	39	23	40	23	42	23	43	23	45	23	47	23	48	23	50
26	23	37	23	39	23	41	23	42	23	44	23	46	23	47	23	48	23	50	23	52	23	53
27	23	41	23	43	23	44	23	46	23	47	23	49	23	51	23	52	23	54	23	55	23	57
28	23	45	23	46	23	48	23	49	23	51	23	53	23	54	23	56	23	57	23	59	24	1
29	23	48	23	50	23	52	23	53	23	55	23	56	23	58	23	59	24	1	24	3	24	4
30	23	52	23	54	23	55	23	57	23	58	24	0	24	1	24	3	24	5	24	6	24	8

A TABLE of Oblique Ascensions in Time, for the Latitude of 53 Deg. And to Five Degrees of North and South Latitude.

North Latitude. ♈. South Latitude. ♈.

Degr.	5		4		3		2		1		0		1		2		3		4		5	
	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'
0	23	27	23	34	23	40	23	47	23	53	0	0	0	6	0	13	0	19	0	26	0	32
1	23	29	23	36	23	42	23	48	23	55	0	1	0	8	0	14	0	21	0	27	0	34
2	23	30	23	37	23	44	23	50	23	57	0	3	0	9	0	16	0	22	0	29	0	35
3	23	32	23	39	23	45	23	52	23	58	0	4	0	11	0	17	0	24	0	30	0	37
4	23	33	23	40	23	47	23	53	24	0	0	6	0	12	0	19	0	26	0	32	0	39
5	23	35	23	42	23	48	23	55	0	1	0	8	0	14	0	21	0	27	0	33	0	40
6	23	36	23	43	23	50	23	56	0	3	0	9	0	16	0	22	0	29	0	35	0	42
7	23	38	23	45	23	51	23	58	0	4	0	11	0	17	0	24	0	30	0	37	0	43
8	23	39	23	46	23	53	23	59	0	6	0	12	0	19	0	25	0	32	0	38	0	45
9	23	41	23	48	23	54	0	1	0	7	0	14	0	20	0	27	0	33	0	40	0	47
10	23	43	23	49	23	56	0	2	0	9	0	15	0	22	0	28	0	35	0	41	0	48
11	23	44	23	51	23	57	0	4	0	11	0	17	0	23	0	30	0	37	0	43	0	50
12	23	46	23	52	23	59	0	5	0	22	0	19	0	25	0	32	0	38	0	45	0	51
13	23	47	23	54	0	2	0	7	0	14	0	20	0	27	0	33	0	40	0	46	0	53
14	23	49	23	55	0	4	0	9	0	15	0	22	0	28	0	35	0	42	0	48	0	54
15	2	350	23	57	0	5	0	10	0	17	0	23	0	30	0	37	0	43	0	50	0	56
16	23	52	23	58	0	7	0	12	0	19	0	25	0	32	0	38	0	45	0	51	0	58
17	23	53	0	0	0	8	0	13	0	20	0	27	0	33	0	40	0	46	0	53	0	59
18	23	55	0	2	0	10	0	15	0	22	0	28	0	35	0	41	0	48	0	54	1	1
19	23	56	0	3	0	12	0	17	0	23	0	30	0	36	0	43	0	50	0	56	1	2
20	23	58	0	5	0	13	0	18	0	25	0	32	0	38	0	45	0	51	0	58	1	4
21	23	59	0	6	0	15	0	20	0	27	0	33	0	40	0	47	0	53	1	0	1	6
22	0	1	0	8	0	16	0	21	0	28	0	35	0	42	0	48	0	55	1	1	1	8
23	0	2	0	9	0	18	0	23	0	30	0	37	0	43	0	50	0	56	1	3	1	9
24	0	4	0	11	0	20	0	25	0	32	0	38	0	45	0	52	0	58	1	5	1	11
25	0	6	0	13	0	21	0	26	0	33	0	40	0	47	9	53	1	0	1	7	1	13
26	0	7	0	14	0	23	0	28	0	35	0	42	0	49	0	55	1	2	1	8	1	15
27	0	9	0	16	0	25	0	30	0	37	0	43	0	50	0	57	1	4	1	10	1	16
28	0	10	0	18	0	26	0	32	0	38	0	45	0	52	0	59	1	5	1	12	1	18
29	0	12	0	19	0	28	0	33	0	40	0	47	0	54	1	1	1	7	1	14	1	20
30	0	14	0	21	0	29	0	35	0	42	0	50	0	56	1	2	1	9	1	16	1	22

A TABLE of Oblique Ascensions in Time, for the Latitude of 53 Deg. And to Five Degrees of North and South Latitude.

	North Latitude. ♉												South Latitude. ♉									
Degr.	5		4		3		2		1		0		1		2		3		4		5	
	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'
0	0	14	0	21	0	28	0	35	0	42	0	50	0	56	1	2	1	9	1	16	1	22
1	0	15	0	23	0	30	0	37	0	44	0	51	0	58	1	4	1	11	1	18	1	24
2	0	17	0	24	0	32	0	39	0	46	0	52	0	59	1	6	1	13	1	19	1	26
3	0	19	0	26	0	33	0	40	0	47	0	54	1	1	1	8	1	15	1	21	1	28
4	0	20	0	28	0	35	0	42	0	49	0	56	1	3	1	10	1	17	1	23	1	30
5	0	22	0	30	0	37	0	44	0	51	0	58	1	5	1	12	1	19	1	25	1	32
6	0	24	0	31	0	39	0	46	0	53	1	0	1	7	1	14	1	21	1	27	1	34
7	0	26	0	33	0	41	0	48	0	55	1	2	1	9	1	16	1	23	1	29	1	36
8	0	27	0	35	0	42	0	50	0	57	1	4	1	11	1	18	1	25	1	31	1	38
9	0	29	0	37	0	44	0	52	0	59	1	6	1	13	1	20	1	27	1	33	1	40
10	0	31	0	39	0	46	0	54	1	1	1	8	1	15	1	22	1	29	1	35	1	42
11	0	33	0	41	0	48	0	56	1	3	1	10	1	17	1	24	1	31	1	37	1	44
12	0	34	0	42	0	50	0	58	1	5	1	12	1	19	1	26	1	33	1	40	1	46
13	0	36	0	44	0	52	1	0	1	7	1	14	1	21	1	28	1	35	1	42	1	49
14	0	38	0	46	0	54	1	2	1	9	1	16	1	23	1	30	1	37	1	44	1	51
15	0	40	0	48	0	59	1	4	1	11	1	18	1	25	1	33	1	39	1	46	1	53
16	0	42	0	50	0	58	1	6	1	13	1	20	1	28	1	35	1	42	1	49	1	55
17	0	44	0	52	1	0	1	8	1	15	1	23	1	30	1	37	1	44	1	51	1	58
18	0	46	0	54	1	2	1	10	1	18	1	25	1	32	1	39	1	46	1	53	2	0
19	0	48	0	56	1	4	1	12	1	20	1	27	1	34	1	41	1	49	1	55	2	2
20	0	50	0	58	1	7	1	14	1	22	1	29	1	37	1	44	1	51	1	58	2	5
21	0	52	1	1	1	9	1	16	1	24	1	32	1	39	1	46	1	53	2	0	2	7
22	0	54	1	3	1	11	1	19	1	26	1	34	1	41	1	49	1	56	2	3	2	9
23	0	57	1	5	1	13	1	21	1	29	1	36	1	44	1	51	1	58	2	5	2	12
24	0	59	1	7	1	15	1	23	1	31	1	38	1	46	1	53	2	1	2	7	2	14
25	1	1	1	10	1	18	1	26	1	34	1	41	1	49	1	56	2	3	2	10	2	17
26	1	3	1	12	1	20	1	28	1	36	1	44	1	51	1	59	2	6	2	13	2	20
27	1	6	1	14	1	23	1	30	1	39	1	46	1	54	2	1	2	8	2	15	2	22
28	1	8	1	17	1	25	1	33	1	41	1	49	1	57	2	4	2	11	2	18	2	25
29	1	10	1	19	1	28	1	36	1	44	1	52	1	59	2	7	2	14	2	21	2	28
30	1	13	1	22	1	30	1	39	1	46	1	54	2	2	2	9	2	17	2	24	2	30

A TABLE of Oblique Ascensions in Time, for the Latitude of 53 Deg. And to Five Degrees of North and South Latitude.

	North Latitude. ♊.												South Latitude. ♊.									
	5		4		3		2		1		0		1		2		3		4		5	
Degr.	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'
0	1	13	1	22	1	30	1	39	1	47	1	54	2	2	2	4	2	16	2	24	2	30
1	1	15	1	24	1	33	1	41	1	49	1	57	2	5	2	12	2	19	2	26	2	33
2	1	18	1	27	1	35	1	44	1	52	2	0	2	7	2	15	2	22	2	29	2	36
3	1	21	1	30	1	38	1	46	1	55	2	3	2	10	2	18	2	25	2	32	2	39
4	1	23	1	32	1	41	1	49	1	58	2	6	2	13	2	21	2	28	2	35	2	42
5	1	26	1	35	1	44	1	52	2	1	2	8	2	16	2	24	2	31	2	38	2	45
6	1	29	1	38	1	47	1	55	2	3	2	11	2	19	2	26	2	34	2	41	2	48
7	1	32	1	41	1	50	1	58	2	6	2	14	2	22	2	24	2	37	2	44	2	51
8	1	34	1	44	1	53	2	1	2	9	2	17	2	25	2	33	2	40	2	47	2	54
9	1	37	1	47	1	56	2	4	2	12	2	21	2	28	2	36	2	43	2	50	2	57
10	1	40	1	50	1	59	2	7	2	16	2	24	2	31	2	39	2	46	2	5[illegible]	3	0
11	1	43	1	53	2	2	2	11	2	19	2	27	2	34	2	42	2	49	2	57	3	4
12	1	47	1	56	2	5	2	14	2	22	2	30	2	38	2	45	2	53	3	0	3	7
13	1	50	1	59	2	8	2	17	2	25	2	33	2	41	2	49	2	56	3	3	3	10
14	1	53	2	3	2	12	2	20	2	29	2	37	2	45	2	52	3	0	3	7	3	14
15	1	56	2	6	2	15	2	24	2	32	2	40	2	48	2	56	3	3	3	10	3	17
16	2	0	2	10	2	19	2	27	2	36	2	44	2	52	2	59	3	7	3	14	3	21
17	2	3	2	13	2	22	2	31	2	39	2	47	2	55	3	3	3	10	3	17	3	24
18	2	7	2	17	2	26	2	34	2	43	2	51	2	59	3	6	3	14	3	21	3	28
19	2	11	2	20	2	29	2	38	2	47	2	55	3	3	3	10	3	17	3	24	3	31
20	2	14	2	24	2	33	2	42	2	50	2	58	3	6	3	14	3	21	3	28	3	35
21	2	18	2	28	2	37	2	46	2	54	3	2	3	10	3	17	3	25	3	32	3	39
22	2	22	2	32	2	41	2	49	2	58	3	6	3	14	3	21	3	28	3	36	3	42
23	2	26	2	36	2	45	2	53	3	2	3	10	3	18	3	25	3	32	3	39	3	46
24	2	30	2	40	2	49	2	57	3	6	3	14	3	22	3	29	3	36	3	43	3	50
25	2	34	2	44	2	53	3	2	3	10	3	18	3	26	3	33	3	40	3	47	3	54
26	2	38	2	48	2	57	3	6	3	14	3	22	3	30	3	37	3	44	3	[illegible]1	3	58
27	2	42	2	52	3	1	3	10	3	18	3	26	3	34	3	41	3	48	3	5[illegible]	4	2
28	2	47	2	56	3	6	3	14	3	22	3	30	3	38	3	45	3	53	3	59	4	6
29	2	51	3	1	3	10	3	19	3	27	3	35	3	42	3	49	3	57	4	4	4	10
30	2	56	3	5	3	14	3	23	3	31	3	39	3	47	3	53	4	1	4	8	4	15

A TABLE of Oblique Ascensions in Time, for the Latitude of 53 Deg. And to Five Degrees of North and South Latitude.

North Latitude. ♋. South Latitude. ♋.

Degr.	5		4		3		2		1		0		1		2		3		4		5	
	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'
0	2	56	3	5	3	14	3	23	3	31	3	39	3	47	3	54	4	1	4	8	4	15
1	3	0	3	10	3	19	3	27	3	36	3	43	3	51	3	58	4	5	4	12	4	19
2	3	5	3	14	3	23	3	32	3	40	3	48	3	55	4	3	4	10	4	17	4	23
3	3	9	3	19	3	28	3	37	3	45	3	52	4	0	4	7	4	14	4	21	4	27
4	3	14	3	24	3	33	3	41	3	49	3	57	4	4	4	12	4	19	4	25	4	32
5	3	19	3	29	3	38	3	46	3	54	4	2	4	9	4	16	4	23	4	30	4	36
6	3	24	3	34	3	42	3	51	3	59	4	6	4	14	4	21	4	28	4	34	4	41
7	3	29	3	39	3	47	3	55	4	3	4	11	4	18	4	25	4	32	4	39	4	45
8	3	34	3	44	3	52	4	0	4	8	4	16	4	23	4	30	4	37	4	43	4	50
9	3	39	3	48	3	57	4	5	4	13	4	21	4	28	4	35	4	41	4	48	4	54
10	3	45	3	54	4	2	4	10	4	18	4	25	4	33	4	40	4	46	4	53	4	59
11	3	50	3	59	4	7	4	15	4	23	4	30	4	38	4	44	4	51	4	57	5	4
12	3	55	4	4	4	13	4	20	4	28	4	35	4	42	4	49	4	56	5	2	5	8
13	4	1	4	10	4	18	4	26	4	33	4	40	4	48	4	54	5	1	5	7	5	13
14	4	6	4	15	4	23	4	31	4	38	4	45	4	52	4	59	5	6	5	12	5	18
15	4	12	4	20	4	28	4	36	4	44	4	51	4	57	5	4	5	10	5	17	5	23
16	4	17	4	26	4	34	4	41	4	49	4	56	5	2	5	9	5	15	5	22	5	28
17	4	23	4	31	4	39	4	47	4	54	5	1	5	8	5	14	5	20	5	27	5	33
18	4	29	4	37	4	45	4	52	4	59	5	6	5	13	5	19	5	25	5	32	5	37
19	4	34	4	43	4	50	4	58	5	5	5	12	5	18	5	24	5	31	5	37	5	42
20	4	40	4	48	4	56	5	3	5	10	5	17	5	23	5	30	5	36	5	42	5	47
21	4	46	4	54	5	1	5	9	5	16	5	22	5	29	5	35	5	41	5	47	5	52
22	4	52	5	0	5	7	5	14	5	21	5	28	5	34	5	40	5	46	5	52	5	57
23	4	58	5	5	5	13	5	20	5	27	5	33	5	39	5	45	5	51	5	57	6	3
24	5	4	5	11	5	18	5	25	5	32	5	39	5	45	5	51	5	56	6	2	6	8
25	5	10	5	17	5	24	5	31	5	38	5	44	5	50	5	56	6	2	6	7	6	13
26	5	16	5	23	5	30	5	37	5	43	5	49	5	56	6	1	6	7	6	13	6	18
27	5	22	5	29	5	36	5	42	5	49	5	55	6	1	6	7	5	13	6	18	6	23
28	5	28	5	35	5	42	5	48	5	54	6	1	6	7	6	12	6	18	6	23	6	28
29	5	34	5	41	5	48	5	54	6	0	6	6	6	12	6	18	6	23	6	29	6	33
30	5	40	5	47	5	53	6	0	6	6	6	12	6	18	6	23	6	29	6	34	6	38

A TABLE of Oblique Ascensions in Time, for the Latitude of 53 Deg. And to Five Degrees of North and South Latitude.

	North Latitude. ♌.												South Latitude. ♌.									
Degr.	5		4		3		2		1		0		1		2		3		4		5	
	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'
0	5	40	5	47	5	53	6	0	6	6	6	12	6	18	6	23	6	29	6	34	6	37
1	5	46	5	53	5	59	6	6	6	12	6	18	6	23	6	29	6	34	6	39	6	44
2	5	52	5	59	6	5	6	11	6	17	6	23	6	29	6	34	6	39	6	4[illegible]	6	50
3	5	58	6	5	6	11	6	17	6	23	6	29	6	34	6	40	6	45	6	5[illegible]	6	55
4	6	4	6	11	6	17	6	23	6	29	6	35	6	40	6	46	6	51	6	56	7	1
5	6	11	6	17	6	23	6	29	6	35	6	40	6	46	6	51	6	56	7	1	7	6
6	6	17	6	23	6	29	6	35	6	41	6	46	6	51	6	57	7	2	7	6	7	11
7	6	22	6	29	6	35	6	41	6	46	6	52	6	57	7	2	7	7	7	12	7	17
8	6	29	6	35	6	41	6	47	6	52	6	57	7	3	7	8	7	13	7	17	7	22
9	6	35	6	41	6	47	6	53	6	58	7	3	7	8	7	13	7	18	7	23	7	28
10	6	42	6	47	6	53	6	59	7	4	7	9	7	14	7	19	7	24	7	29	7	33
11	6	48	6	54	6	59	7	4	7	10	7	15	7	20	7	25	7	29	7	34	7	39
12	6	54	7	0	7	5	7	11	7	16	7	21	7	26	7	30	7	35	7	40	7	44
13	7	0	7	6	7	11	7	16	7	22	7	26	7	31	7	35	7	41	7	45	7	50
14	7	6	7	12	7	17	7	22	7	27	7	32	7	37	7	41	7	46	7	51	7	55
15	7	13	7	18	7	23	7	28	7	33	7	38	7	43	7	47	7	52	7	56	8	1
16	7	19	7	24	7	29	7	34	7	39	7	44	7	49	7	53	7	58	8	2	8	6
17	7	25	7	30	7	35	7	40	7	45	7	50	7	54	7	59	8	3	8	8	8	12
18	7	31	7	37	7	41	7	46	7	51	7	56	8	0	8	4	8	9	8	13	8	17
19	7	38	7	43	7	48	7	52	7	57	8	1	8	6	8	10	8	15	8	19	8	23
20	7	44	7	49	7	54	7	58	8	3	8	7	8	12	8	16	8	20	8	24	8	29
21	7	50	7	55	8	0	8	4	8	9	8	13	8	17	8	22	8	26	8	30	8	34
22	7	56	8	1	8	6	8	10	8	15	8	19	8	23	8	27	8	32	8	36	8	40
23	8	2	8	7	8	12	8	16	8	21	8	25	8	29	8	33	8	37	8	41	8	45
24	8	8	8	13	8	18	8	22	8	26	8	31	8	35	8	38	8	43	8	47	8	51
25	8	14	8	19	8	24	8	28	8	32	8	37	8	41	8	45	8	49	8	53	8	57
26	8	21	8	25	8	30	8	34	8	38	8	42	8	46	8	51	8	55	8	58	9	2
27	8	27	8	31	8	36	8	40	8	44	8	48	8	52	8	56	9	0	9	4	9	8
28	8	33	8	37	8	42	8	46	8	50	8	54	8	58	9	2	9	6	9	10	9	13
29	8	39	8	43	8	48	8	52	8	56	9	0	9	4	9	8	9	12	9	15	9	19
30	8	45	8	49	8	54	8	58	9	2	9	6	9	10	9	13	9	17	9	21	9	25

A TABLE of Oblique Ascensions in Time, for the Latitude of 53 Deg. And to Five Degrees of North and South Latitude.

Degr.	North Latitude. ♍																	South Latitude. ♍.				
	5		4		3		2		1		0		1		2		3		4		5	
	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h		h	'	h	'
0	8	45	8	49	8	54	8	58	9	2	9	6	9	10	9	13	9	17	9	21	9	25
1	8	51	8	55	9	0	9	4	9	8	9	12	9	15	9	19	9	23	9	27	9	30
2	8	57	9	2	9	6	9	10	9	13	9	17	9	21	9	25	9	29	9	32	9	36
3	9	3	9	8	9	12	9	15	9	19	9	23	9	27	9	31	9	34	9	38	9	42
4	9	10	9	14	9	18	9	21	9	25	9	28	9	33	9	36	9	40	9	44	9	47
5	9	16	9	20	9	24	9	27	9	31	9	35	9	39	9	42	9	46	9	49	9	53
6	9	22	9	26	9	29	9	33	9	37	9	41	9	44	9	48	9	52	9	55	9	59
7	9	28	9	32	9	35	9	39	9	43	9	47	9	50	9	54	9	57	10	1	10	4
8	9	34	9	38	9	41	9	45	9	49	9	52	9	56	10	0	10	3	10	7	10	10
9	9	40	9	44	9	47	9	51	9	55	9	58	10	2	10	5	10	9	10	12	10	16
10	9	46	9	50	9	53	9	57	10	1	10	4	10	8	10	11	10	15	10	18	10	22
11	9	52	9	55	9	59	10	3	10	6	10	10	10	13	10	17	10	20	10	24	10	27
12	9	58	10	1	10	5	10	10	10	12	10	16	10	19	10	23	10	26	10	30	10	33
13	10	4	10	7	10	11	10	15	10	18	10	22	10	25	10	28	10	32	10	35	10	39
14	10	10	10	13	10	17	10	20	10	24	10	27	10	31	10	34	10	38	10	41	10	44
15	10	16	10	19	10	23	10	26	10	30	10	33	10	37	10	40	10	43	10	47	10	50
16	10	21	10	25	10	29	10	32	10	35	10	39	10	42	10	46	10	49	10	52	10	56
17	10	27	10	31	10	34	10	39	10	41	10	45	10	48	10	51	10	55	10	58	11	1
18	10	33	10	37	10	40	10	44	10	47	10	50	10	54	10	57	11	1	11	4	11	7
19	10	39	10	42	10	46	10	50	10	53	10	56	11	0	11	3	11	6	11	10	11	13
20	10	45	10	49	10	52	10	55	10	59	11	2	11	5	11	9	11	12	11	15	11	19
21	10	51	10	54	10	58	11	1	11	5	11	8	11	11	11	15	11	18	11	21	11	25
22	10	57	11	0	11	4	11	7	11	10	11	14	11	17	11	20	11	24	11	27	11	30
23	11	3	11	6	11	10	11	13	11	16	11	20	11	23	11	25	11	29	11	33	11	36
24	11	9	11	12	11	15	11	19	11	22	11	25	11	29	11	32	11	35	11	38	11	43
25	11	14	11	18	11	21	11	24	11	28	11	31	11	34	11	38	11	41	11	44	11	48
26	11	20	11	24	11	27	11	30	11	34	11	37	11	40	11	44	11	47	11	50	11	53
27	11	26	11	29	11	33	11	36	11	39	11	43	11	46	11	49	11	52	11	56	11	59
28	11	32	11	35	11	39	11	42	11	45	11	48	11	52	11	55	11	58	12	2	12	5
29	11	38	11	41	11	44	11	48	11	51	11	54	11	57	12	1	12	4	12	7	12	11
30	11	43	11	47	11	50	11	53	11	57	12	0	12	3	12	7	12	10	12	13	12	17

A TABLE of Oblique Ascensions in Time, for the Latitude of 53 Deg. And to Five Degrees of North and South Latitude.

North Latitude. ♎. South Latitude. ♎.

Degr.	5		4		3		2		1		0		1		2		3		4		5	
	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'
0	11	43	11	47	11	50	11	53	11	57	12	0	12	3	12	7	12	10	12	13	12	17
1	11	49	11	53	11	56	11	59	12	3	12	6	12	9	12	12	12	16	12	19	12	22
2	11	55	11	58	12	2	12	5	12	8	12	11	12	15	12	18	12	21	12	25	12	28
3	12	1	12	4	12	8	12	11	12	14	12	17	12	21	12	24	12	27	12	31	12	34
4	12	7	12	10	12	13	12	16	12	20	12	23	12	26	12	30	12	33	12	36	12	40
5	12	12	12	16	12	19	12	22	12	26	12	29	12	32	12	36	12	39	12	42	12	46
6	12	18	12	22	12	25	12	28	12	31	12	35	12	38	12	41	12	45	12	48	12	51
7	12	24	12	27	12	31	12	35	12	37	12	40	12	44	12	47	12	50	21	54	12	57
8	12	30	12	33	12	36	12	40	12	43	12	46	12	50	12	53	12	56	13	0	13	3
9	12	35	12	39	12	42	12	45	12	49	12	52	12	56	12	59	13	2	13	6	13	9
10	12	41	12	45	12	48	12	51	12	55	12	58	13	1	13	5	13	8	13	11	13	15
11	12	47	12	50	12	54	12	57	13	0	13	4	13	7	13	10	13	4	13	18	13	21
12	12	53	12	56	12	59	13	3	13	6	13	10	13	13	13	16	13	20	13	23	13	27
13	12	59	13	2	13	5	13	8	13	12	13	15	13	19	13	21	13	26	13	29	13	33
14	13	4	13	8	13	11	13	14	13	18	13	21	13	25	13	28	13	31	13	35	13	39
15	13	10	13	13	13	17	13	20	13	23	13	27	13	30	13	34	13	37	13	41	13	44
16	13	16	13	19	13	22	13	26	13	29	13	33	13	36	13	40	13	43	13	47	13	50
17	13	21	13	25	13	28	13	32	13	35	13	38	13	42	13	45	13	49	13	53	13	56
18	13	27	13	30	13	34	13	37	13	41	13	44	13	48	13	50	13	55	13	59	14	2
19	13	33	13	36	13	40	13	43	13	47	13	50	13	54	13	57	14	1	14	5	14	8
20	13	38	13	42	13	45	13	49	13	52	13	56	13	59	14	3	14	7	14	10	14	14
21	13	44	13	48	13	51	13	55	13	58	14	2	14	5	14	9	14	13	14	16	14	20
22	13	50	13	53	13	57	14	0	14	4	14	8	14	11	14	15	14	19	14	22	14	26
23	13	56	13	59	14	3	14	6	14	10	14	13	14	17	14	21	14	25	14	28	14	32
24	14	1	14	5	14	8	14	12	14	16	14	19	14	23	14	27	14	31	14	34	14	38
25	14	7	14	11	14	14	14	18	14	21	14	25	14	29	14	33	14	36	14	40	14	44
26	14	13	14	16	14	20	14	24	14	27	14	32	14	35	14	39	14	42	14	46	14	50
27	14	18	14	22	14	26	14	29	14	33	14	37	14	41	14	45	14	48	14	52	14	57
28	14	24	14	28	14	31	14	35	14	39	14	43	14	47	14	50	14	54	14	58	15	3
29	14	30	14	33	14	37	14	41	14	45	14	48	14	52	14	56	15	0	15	5	15	9
30	14	35	14	39	14	43	14	47	14	50	14	54	14	59	15	2	15	6	15	11	15	15

A TABLE of Oblique Ascensions in Time, for the Latitude of 53 Deg. And to Five Degrees of North and South Latitude.

	North Latitude. ♏.												South Latitude. ♏.									
	5		4		3		2		1		0		1		2		3		4		5	
Degr.	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h		h	'	h	'
0	14	35	14	39	14	43	14	47	14	50	14	54	14	59	15	2	15	6	15	11	15	15
1	14	41	14	45	14	48	14	52	14	56	15	0	15	4	15	8	15	12	15	17	15	21
2	14	47	14	40	14	54	14	54	15	2	15	6	15	10	15	14	15	18	15	23	15	27
3	14	52	14	56	15	0	15	4	15	8	15	12	15	16	15	20	15	24	15	29	15	33
4	14	58	15	2	15	5	15	9	15	14	15	18	15	23	15	26	15	30	15	35	15	39
5	15	3	15	7	15	11	15	15	15	19	15	23	15	28	15	32	15	36	15	41	15	46
6	15	9	15	13	15	17	15	22	15	25	15	29	15	34	15	38	15	42	15	47	15	52
7	15	15	15	19	15	23	15	27	15	31	15	35	15	39	15	44	15	48	15	53	15	58
8	15	20	15	24	15	28	15	33	15	37	15	41	15	45	15	50	15	54	15	59	16	4
9	15	26	15	30	15	34	15	38	15	43	15	47	15	51	15	56	16	0	16	5	16	10
10	15	31	15	36	15	40	15	44	15	48	15	53	15	57	16	2	16	6	16	11	16	16
11	15	37	15	41	15	45	15	50	15	54	15	59	16	3	16	8	16	12	16	17	16	22
12	15	43	15	47	15	51	15	56	16	0	16	4	16	9	16	14	16	19	16	23	16	29
13	15	48	15	52	15	57	16	1	16	6	16	10	16	15	16	20	16	25	16	30	16	35
14	15	54	15	58	16	2	16	7	16	11	16	16	16	21	16	26	16	31	16	36	16	41
15	15	59	16	4	16	8	16	13	16	17	16	22	16	27	16	32	16	37	16	42	16	47
16	16	5	16	9	16	14	16	19	16	23	16	28	16	33	16	38	16	43	16	48	16	54
17	16	10	16	15	16	19	16	25	16	29	16	34	16	38	16	44	16	49	16	54	17	0
18	16	16	16	20	16	25	16	30	16	34	16	39	16	44	16	49	16	55	17	0	17	6
19	16	21	16	26	16	31	16	35	16	40	16	45	16	50	16	56	17	1	17	6	17	12
20	16	27	16	31	16	36	16	41	16	46	16	51	16	56	17	1	17	7	17	13	17	18
21	16	32	16	37	16	42	16	47	16	52	16	57	17	2	17	7	17	13	17	19	17	25
22	15	38	16	43	16	47	16	52	16	57	17	3	17	8	17	13	17	19	17	25	17	31
23	16	43	16	48	16	53	16	58	17	3	17	8	17	14	17	19	17	25	17	31	17	37
24	16	49	16	54	16	58	17	3	17	9	17	14	17	19	17	25	17	31	17	37	17	43
25	16	54	16	59	17	4	17	9	17	14	17	20	17	25	17	31	17	37	17	43	17	49
26	16	59	17	4	17	9	17	14	17	20	17	25	17	31	17	37	17	43	17	49	17	56
27	17	5	17	10	17	15	17	20	17	26	17	31	17	37	17	43	17	49	17	55	18	2
28	17	10	17	15	17	21	17	26	17	31	17	37	17	43	17	49	17	55	18	1	18	8
29	17	16	17	21	17	26	17	31	17	37	17	42	17	48	17	54	18	1	18	7	18	14
30	17	21	17	26	17	31	17	37	17	42	17	48	17	54	18	0	18	7	18	13	18	20

A TABLE of Oblique Ascensions in Time, for the Latitude of 53 Deg. And to Five Degrees of North and South Latitude.

	North Latitude. ♐.												South Latitude. ♐.									
	5		4		3		2		1		0		1		2		3		4		5	
Degr.	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'
0	17	21	17	26	17	31	17	37	17	42	17	48	17	54	18	0	18	7	18	13	18	20
1	17	26	17	31	17	37	17	42	17	48	17	54	18	0	18	6	18	12	18	19	18	26
2	17	31	17	37	17	42	17	48	17	53	17	59	18	6	18	12	18	28	18	25	18	32
3	17	37	17	42	17	47	17	53	17	59	18	5	18	11	18	18	18	24	18	31	18	38
4	17	42	17	47	17	53	17	59	18	4	18	11	18	17	18	23	18	30	18	37	18	44
5	17	47	17	53	17	58	18	4	18	10	18	16	18	22	18	29	18	36	18	43	18	50
6	17	52	17	58	18	4	18	9	18	15	18	21	18	28	18	35	18	42	18	49	18	56
7	17	57	18	3	18	9	18	15	18	21	18	27	18	33	18	40	18	47	18	55	19	2
8	18	3	18	8	18	14	18	20	18	26	18	32	18	39	18	46	18	53	19	0	19	8
9	18	8	18	13	18	19	18	25	18	31	18	38	18	44	18	51	18	59	19	6	19	14
10	18	13	18	18	18	24	18	30	18	37	18	43	18	50	18	57	19	4	19	12	19	20
11	18	18	18	23	18	29	18	36	18	42	18	48	18	55	19	2	19	10	19	17	19	26
12	18	23	18	28	18	35	18	41	18	47	18	54	19	1	19	8	19	15	19	23	19	31
13	18	27	18	33	18	40	18	46	18	52	18	59	19	6	19	13	19	21	19	29	19	37
14	18	32	18	38	18	45	18	51	18	58	19	4	19	11	19	19	19	26	19	34	19	43
15	18	37	18	43	18	40	18	56	19	3	19	9	19	16	19	24	19	32	19	40	19	48
16	18	42	18	48	18	54	19	1	19	8	19	15	19	22	19	29	19	37	19	45	19	54
17	18	47	18	53	18	59	19	6	19	12	19	20	19	27	19	34	19	42	19	50	19	59
18	18	52	18	58	19	4	19	11	19	17	19	25	19	32	19	40	19	47	19	56	20	5
19	18	56	19	3	19	9	19	16	19	22	19	30	19	37	19	45	19	53	20	1	20	10
20	19	1	19	7	19	14	19	20	19	27	19	35	19	42	19	50	19	58	20	6	20	15
21	19	6	19	12	19	19	19	25	19	32	19	39	19	47	19	55	20	3	20	12	20	21
22	19	10	19	17	19	23	19	30	19	37	19	44	19	52	20	0	20	8	20	16	20	26
23	19	15	19	21	19	28	19	35	19	42	19	49	19	57	20	5	20	13	20	21	20	31
24	19	19	19	26	19	32	19	39	19	46	19	54	20	1	20	9	20	18	20	26	20	36
25	19	24	19	30	19	37	19	44	19	51	19	58	20	6	20	14	20	22	20	31	20	41
26	19	28	19	35	19	41	19	48	19	56	20	3	20	11	20	19	20	27	20	36	20	46
27	19	33	19	39	19	46	19	53	20	0	20	8	20	15	20	23	20	32	20	41	20	51
28	19	37	19	43	19	50	19	57	20	5	20	12	20	20	20	28	20	37	20	46	20	55
29	19	41	19	48	19	55	20	2	20	9	20	17	20	24	20	33	20	41	20	50	21	0
30	19	45	19	52	19	59	20	6	20	13	20	21	20	29	20	37	20	46	20	55	21	4

A TABLE of Oblique Ascensions in Time, for the Latitude of 53 Deg. And to Five Degrees of North and South Latitude.

North Latitude. ♑. South Latitude. ♑.

Degr.	5		4		3		2		1		0		1		2		3		4		5	
	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h		h	'	h	'
0	19	45	19	52	19	59	20	6	20	13	20	21	20	29	20	37	20	46	20	55	21	4
1	19	50	19	56	20	3	20	11	20	18	20	25	20	33	20	41	20	50	20	59	21	9
2	19	54	20	1	20	7	20	15	20	22	20	30	20	38	20	46	20	54	21	4	21	13
3	19	58	20	5	20	12	20	19	20	26	20	34	20	42	20	50	20	59	21	8	21	18
4	20	2	20	9	20	16	20	23	20	30	20	38	20	46	20	54	21	3	21	12	21	32
5	20	6	00	13	20	20	20	27	20	34	20	42	20	50	20	58	21	7	21	16	21	26
6	20	10	20	17	20	24	20	31	20	38	20	46	20	54	21	3	21	11	21	20	21	30
7	20	14	20	21	20	28	20	35	20	42	20	50	20	58	21	7	21	15	21	24	21	34
8	20	18	20	24	20	32	20	39	20	46	20	54	21	2	21	11	21	19	21	28	21	38
9	20	21	20	28	20	35	20	43	20	50	20	58	21	6	21	14	21	23	21	32	21	42
10	20	25	20	32	20	39	20	46	20	54	21	2	21	10	21	18	21	27	21	36	21	46
11	20	29	20	36	20	43	20	50	20	57	21	5	21	13	21	22	21	31	21	40	21	49
12	20	33	20	39	20	46	20	54	21	1	21	9	21	17	21	26	21	34	21	43	21	53
13	20	36	20	43	20	50	20	57	21	5	21	13	21	21	21	29	21	38	21	47	21	57
14	20	39	20	46	20	53	21	1	21	8	21	16	21	24	21	33	21	41	21	50	22	0
15	20	43	20	50	20	57	21	4	21	12	21	20	21	28	21	36	21	45	21	54	22	4
16	20	46	20	53	21	0	21	8	21	15	21	23	21	31	21	40	21	48	21	57	22	7
17	20	50	20	57	21	4	21	11	21	19	21	27	21	35	21	43	21	52	22	1	22	10
18	20	53	21	0	21	7	21	15	21	22	21	30	21	38	21	46	21	55	22	4	22	13
19	20	56	21	3	21	11	21	18	21	26	21	33	21	41	21	49	21	58	22	7	22	17
20	21	0	21	7	21	14	21	22	21	29	21	36	21	44	21	53	22	1	22	10	22	20
21	21	3	21	10	21	17	21	24	21	32	21	39	21	48	21	56	22	4	22	13	22	23
22	21	6	21	13	21	20	21	27	21	35	21	43	21	51	21	59	22	7	22	16	22	26
23	21	9	21	16	21	23	21	31	21	38	21	46	21	54	22	2	22	10	22	19	22	29
24	21	12	21	19	21	26	21	34	21	41	21	49	21	57	22	5	22	13	22	22	22	31
25	21	15	21	22	21	29	21	36	21	44	21	52	21	59	22	8	22	16	22	25	22	34
26	21	18	21	25	21	32	21	39	21	47	21	54	22	2	22	11	22	19	22	27	22	37
27	21	21	21	28	21	35	21	42	21	50	21	57	22	5	22	14	22	22	22	30	22	39
28	21	24	21	31	21	38	21	45	21	53	22	0	22	8	22	16	22	25	22	33	22	42
29	21	27	21	34	21	41	21	48	21	55	22	3	22	11	22	19	22	27	22	36	22	45
30	21	30	21	36	21	44	21	51	21	58	22	6	22	13	22	21	22	30	22	38	22	48

A TABLE of Oblique Ascensions in Time, for the Latitude of 53 Deg. And to Five Degrees of North and South Latitude.

Degr.	North Latitude. ♒												South Latitude. ♒									
	5		4		3		2		1		0		1		2		3		4		5	
	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'	h	'
0	21	30	21	36	21	43	21	51	21	58	22	6	22	12	22	21	22	30	22	38	22	48
1	21	32	21	39	21	46	21	53	22	1	22	8	22	16	22	24	22	32	22	41	22	50
2	21	35	21	42	21	49	21	56	22	3	22	11	22	19	22	27	22	35	22	43	22	52
3	21	38	21	45	21	52	21	59	22	6	22	14	22	21	22	30	22	37	22	46	22	54
4	21	40	21	47	21	54	22	1	22	9	22	16	22	24	22	32	22	40	22	48	22	57
5	21	43	21	50	21	57	22	4	22	11	22	19	22	26	22	34	22	42	22	50	22	59
6	21	46	21	53	21	59	22	7	22	14	22	22	22	29	22	37	22	45	22	53	23	1
7	21	48	21	55	22	2	22	9	22	16	22	24	22	31	22	39	22	47	22	55	23	3
8	21	51	21	57	22	4	22	11	22	19	22	26	22	34	22	41	22	49	22	57	23	6
9	21	53	22	0	22	7	22	14	22	21	22	28	22	36	22	44	22	51	22	59	23	8
10	21	55	22	2	22	9	22	16	22	23	22	31	22	38	22	46	22	53	23	2	23	10
11	21	58	22	5	22	11	22	19	22	26	22	33	22	40	22	48	22	56	23	4	23	12
12	22	0	22	7	22	14	22	21	22	28	22	35	22	42	22	50	22	58	23	6	23	14
13	22	2	22	9	22	16	22	23	22	30	22	37	22	45	22	52	23	0	23	8	23	16
14	22	5	22	11	22	18	22	25	22	32	22	40	22	47	22	54	23	2	23	10	23	18
15	22	7	22	14	22	21	22	27	22	35	22	42	22	49	22	56	23	4	23	12	23	20
16	22	9	22	16	22	23	22	30	22	37	22	44	22	51	22	58	23	6	23	14	23	22
17	22	11	22	18	22	25	22	32	22	39	22	46	22	53	23	0	23	8	23	16	23	24
18	22	14	22	20	22	27	22	34	22	41	22	48	22	55	23	2	23	10	23	18	23	26
19	22	16	22	23	22	29	22	36	22	43	22	50	22	57	23	4	23	12	23	19	23	27
20	22	18	22	25	22	31	22	38	22	45	22	52	22	59	23	6	23	14	23	21	23	29
21	22	20	22	27	22	33	22	40	22	47	22	54	23	1	23	8	23	16	23	23	23	31
22	22	22	22	29	22	35	22	42	22	49	22	56	23	3	23	10	23	18	23	25	23	33
23	22	24	22	31	22	37	22	44	22	51	22	58	23	5	23	12	23	19	23	27	23	34
24	22	26	22	33	22	39	22	46	22	53	23	0	23	7	23	14	23	21	23	29	23	36
25	22	28	22	35	22	41	22	48	22	55	23	2	23	9	23	16	23	23	23	30	23	38
26	22	30	22	37	22	43	22	50	22	57	23	4	23	11	23	18	23	25	23	33	23	40
27	22	32	22	39	22	45	22	52	22	59	23	6	23	13	23	20	23	27	23	34	23	41
28	22	34	22	41	22	47	22	54	23	1	23	8	23	14	23	21	23	28	23	36	23	43
29	22	36	22	42	22	49	22	56	23	2	23	9	23	16	23	23	23	30	23	37	23	45
30	22	38	22	44	22	51	22	58	23	4	23	11	23	18	23	25	23	32	23	39	23	46